CHEMGENE
NaDCC

EFFERVESCENT CHLORINE

CHEM**GENE** **NaDCC** solution provides a powerful disinfectant that will kill bacteria, fungi, viruses and spores of infectious body spills within 2 minutes (10,000ppm).

Each tablet liberates 1000 part per million (ppm) of available chlorine per 1.5 litres of water. With a shelf life of 5 years, the solution presents as an economic option for treatment of body fluid spills as recommended by most infection control departments.

CHEM**GENE** **NaDCC** is blended with effervescent salts to aid its dispersion without affecting the products ability to generate hypochlorous acid (free available chlorine) in water.

CHEMGENE NaDCC

TECHNICAL DATA

DETAILS OF THE APPLICANT

1.1 Details of the applicant/manufacturer.

Name: Medimark Scientific Ltd

Address: Unit 4 East Point
High Street
Seal
Sevenoaks
Kent
TN15 0EG

Phone: 08452 22 33 44
Fax: 01732 763530
Operating Licence No: UK registered No 07052744

2. IDENTITY

2.1 Commercial name of the product: CHEMGENE NaDCC

2.1.1 Composition of the product:

	1.08g	**1.1g**	**3.5g**	**3.25, 4.72 & 9.7 g**
Sodium dichloro-1,3.5-triazinetrione Anhydrous CAS No 2893-78-9	37%	45.5%	71.4%	53%

2.3 Nature of the product:

Powder (blend) compressed to make a tablet.

CHEMGENE NaDCC's active ingredient, sodium dichloisocyanurate anhydrous (Sodium dichloro-1,3.5triazinetrione Anhydrous) is formulated with effervescent salts to aid its dispersion in water. The volume of effervescent salts does not affect the ability of CHEMGENE NaDCC's to generate hypochlorous acid (free available chlorine) in water.

The volume of effervescent salts varies to suit different in-use applications, water temperatures, markets and packaging method but the actual biocidal performance of the product is unimpaired. (E.G., Where strip foil packaging is required, additional effervescent salts are added to bulk out the tablet to make them large enough to withstand the strip packing activity).

3. NATURAL, CHEMICAL AND TECHNICAL QUALITIES

3.1 Appearance: White flat bevelled tablet.

3.2 Explosive qualities: Not explosive.

3.3 Corrosive qualities: The product itself is not classified as corrosive.

3.4 Flash point: Not flashing.

3.5 pH value: pH (1% water) 5.0-6.0 approx.

3.6 Relative density: Not applicable.

3.7 Stability & Reactivity:

Conditions to Avoid: Do not store on or near heat sources or naked flame. Avoid moisture. NaDCC decomposes at temperatures above 240°C liberating toxic gases.

Materials to Avoid: Contact with water liberates chlorine and with nitrogen compounds may cause explosion. Avoid organic materials, oils, grease, sawdust, reducing agents, nitrogen containing compounds, calcium hypochlorite, other oxidizers, acids, alkalis, cationic and certain non-ionic surfactants.

Effects of dampness: If tablets become damp they will effervesce, evolving carbon dioxide and may decompose to give off chlorine fumes.

Shelf life: 5 years.

3.8 Technical characteristics: Sodium dichloro-1,3,5-triazinetrione anhydrous Disinfectant base.

When the tablet is dissolved in water, Sodium dichloro-1,3,5-triazinetrione anhydrous (NaDCC) primarily forms hypochlorous acid (the active compound) and sodium cyanurate.

3.9 Compatibility with other Products: Compatible with non ionic and anionic surfactants.

4. METHODS OF IDENTIFICATION AND ANALYSIS

4.1 Analytical methods for defining concentration of the active ingredients in the biocidal product.

TEST METHOD STANDARD TITRATION

APPARATUS

Burette 50cm³ (class A)
One-mark pipettes (class A)
One-mark volumetric flask 500cm³ (class A)

REAGENTS

Chemicals of analytical reagent quality
Acetic acid (d= 1.05g/cm³)
Sodium thiosulphate solution 0.1M
Potassium iodide
Starch indicator 0.5% approximately, freshly prepared Water (distilled or de-ionised)

PROCEDURE

Place one tablet in a beaker containing approximately 200cm³ of water and allow to stand until the tablet has completely dissolved. Using a glass rod, ensure any coarse particles remaining are broken up and incorporated into the solution. Transfer the solution to a clean, dry 500cm³ one-mark volumetric flask. Rinse the beaker with two 50cm³ aliquots of water, adding the rinsings to the one-mark volumetric flask. Make up the solution to the mark with water and mix well.

Pipette 25cm³ of the 'chlorine' solution into a clean, dry 250cm³ conical flask. Add 25cm³ of water followed by approximately 2g of the potassium iodide and 10cm³ of the acetic acid. Titrate the liberated iodine with the sodium thiosulphate solution until a pale, straw colour is achieved. Add 2cm³ of the starch solution and titrate until the blue coloration just disappears (V).

CALCULATION

Available chlorine, mg per tablet = V x 3.546 x 20

Alternative test methods are described in the British Standards BS 3762: 1986 and
BS EN ISO 7393-3: 2000.

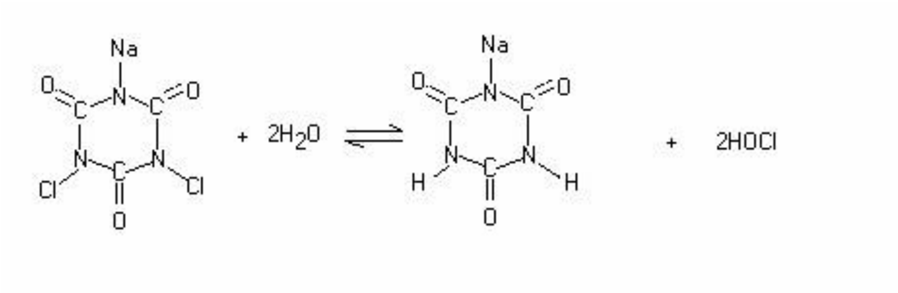
5. PROPOSED USES AND EFFECTIVENESS

5.1 Proposed type of product and application sphere.

The product is made of three components. The active ingredient is sodium dichloro-1,3,5-triazinetrione anhydrous, which has biocidal properties.

The other two components, 1,6-hezane dioic acid and sodium hydrogen carbonate form the effervescent base.

When the tablet is dissolved in water, Sodium dichloro-1,3,5-triazinetrione anhydrous (NaDCC) primarily forms hypochlorous acid (the active compound) and sodium cyanurate.



NaDCC Sodium Cyanurate Hypochlorous acid

It is generally accepted that nonionised hypochlorous acid is responsible for the lethal action on micro-organisms. This action is attributed to the chlorination of the cell protein or enzyme systems. ( )

One of the major factors affecting the antimicrobial activity of the resultant chlorine solutions is the pH.

Hypochlorous acid (HOCl) dissociates according to the following equilibrium

$$HOCl \rightleftharpoons H^{+} + OCl^{-}$$

The hypochlorite ion (OCl^-) and hypochlorous acid (HOCl) contribute the free available chlorine. It should be noted that the hypochlorite ion only has 1/100th of activity of hypochlorous acid. Therefore those solutions liberating the largest amount of hypochlorous acid will have the greatest biocidal activity. Hydrachem's effervescent chlorine tablets have a pH range of 5.0 to 6.0 favouring undissociated HClO (> 95%) in the solution.

The aim of the effervescent base is to speed the dissolution of the tablet in the water.

As the acid effervescent salt, 1,6-hexanedioic acid reacts stoichiometrically with alkaline effevescent salt (sodium hydrogen carbonate) in water as follows:

$$\begin{array}{l} CH_2.CH_2.COOH \\ | \\ CH_2.CH_2.COOH \end{array} + 2NaHCO_3 \rightarrow \begin{array}{l} CH_2.CH_2.COONa \\ | \\ CH_2.CH_2.COONa \end{array} + 2CO_2 + 2H_2O$$

The applications of the product are:

- Private and public health area disinfectants:
  - Non metallic medical and veterinary appliances
  - Mops, cloths and glassware
  - General disinfection
  - Body fluid spills
  - Drains, sinks, W.C. pans, W.C.'s
  - Laboratory discard jars
  - Conditions of heavy soiling

- Veterinary hygiene:
  - General hygiene
  - Conditions of heavy soiling

- Food and feed disinfectants:
  - Food preparation areas; non metallic equipment, containers, consumption utensils, work surfaces, stainless steel (catering grade)
  - Baby bottle sterilisation
  - Disinfection of salads, vegetables, non-peelable fruit

- Drinking water disinfection:
  - Chlorination of animals drinking water
  - Emergency water purification

5.2 Use dilutions, including descriptions of the proposed method of application.

DILUTION TABLE: CHEMGENE NaDCC 4.7G & 3.5G (2.5G NaDCC)		
1TABLETS TABLET IN	**GIVES AVAILABLE CHLORINE OF**	**TYPICAL USES**
150ml	10,000 ppm	Body fluid spills & conditions of heavy soiling
0.6 litre	2,500 ppm	Non metallic medical & veterinary appliances & laboratory discard jars
1.5 litres	1000 ppm	General disinfection
3.75 litres	400 ppm	WC's, drains, sinks
7.5 litres	200 ppm	Food preparation areas
12 litres	125 ppm	Baby bottle sterilisation
15 litres	100 ppm	Cloths & mops

Guidelines for the use of CHEMGENE NaDCC for baby's bottles and feeding equipment :

- After each feed, thoroughly wash and rinse all feeding equipment ensuring all traces of milk are removed.
- Prepare the sterilising solution. Add 1 tablet to the recommended amount of cold or lukewarm water to produce 125 ppm of available chlorine. (Stirring will speed up the tablet dissolution time.)
- Stir solution then immerse all items completely ensuring no trapped air bubbles remain in the bottles or teats.
- Keep items submerged for at least 30 minutes.
- At feeding time, drain and rinse the equipment with cooled, freshly boiled water as used for the feed. Fill the bottle immediately with the feed.
- Wash hands thoroughly after contact with the solution.

MAKE UP FRESH SOLUTION EVERY 24 HOURS
SOLUTION WILL BLEACH – TAKE CARE NOT TO SPLASH AVOID
PROLONGED CONTACT WITH METALS

- Solution can be used for general household and nursery hygiene, eg: wiping and disinfecting non-metallic surfaces, waterproof sheets, changing mats etc.

Guidelines for the use of CHEMGENE NaDCC for glassware, mops and cloths:

- After cleaning mops or cloths, dissolve 1 tablet in the recommended amount of water to produce 100ppm of available chlorine.
- Immerse the cloth or mop in the solution for at least 30 minutes. Do not leave overnight.

Guidelines for the use of CHEMGENE NaDCC for food preparation surfaces and food processing equipment:

- Remove loose debris with a clean, loosely-folded cloth.
- Wash with a hot neutral detergent solution and cloth. An abrasive nylon pad may also be useful.
- Rinse with hot water and a clean cloth.
- Drop one CHEMGENE NaDCC disinfection tablet into the recommended amount of water, preferably warm (40°C) to provide 200 ppm of available chlorine. (Warm water assists the process of disinfection and also speeds up the tablet dissolution time.)
- Thoroughly wet the cleaned surface with the disinfecting solution by the most suitable means, e.g. trigger spray or disposable cloth.
- Leave wet for a minimum of 3 minutes. (Providing the surface is thoroughly clean this is sufficient contact time for positive disinfection.)
- Rinse off with fresh, clean water.
- Allow to air-dry or use disposable paper towel.

IN THE CASE OF DANGEROUS OR ELECTRICAL EQUIPMENT (E.G. SLICING MACHINES), PRELIMINARY SAFETY PROCEDURES AND FINAL SAFETY CHECKS WILL BE REQUIRED, SEVERAL TYPES OF EQUIPMENT WILL NEED PARTIAL OR COMPLETE DISMANTLING TO ENSURE EFFECTIVE CLEANING AND DISINFECTION.

WARNING: TO BE EFFECTIVE, DISINFECTANT SOLUTIONS MUST BE MADE UP FRESH EACH DAY AND BE OF CORRECT CONCENTRATION.

Guidelines for the use of CHEMGENE NaDCC for Veterinary application:

Solutions prepared using CHEMGENE NaDCC tablets are recommended for the prevention and control of mastitis in cows. The CHEMGENE NaDCC solution is active against all mastitis organisms and assists the healing and prevention of teat lesions (40, 41, 42, 43, 44).

Directions of Use:

- Prepare CHEMGENE NaDCC solutions when required using clean utensils.
- Ensure that hands are dry when handling tablets.
- Securely replace the lid on the CHEMGENE NaDCC container.
- Prepare CHEMGENE NaDCC solutions at least five minutes before use.
- Allow tablets to dissolve completely before use.
- CHEMGENE NaDCC solutions, when protected from sunlight and maintained at ambient temperature, can be stored for seven days.
- When used as a teat dip, place the required volume of solution in an appropriate vessel. Discard the contents of the vessel immediately after use. Clean and dry the vessel before re-use.
- When used as a teat spray, firstly flush out all traces of previous teat spray product from spray lines, spray guns and containers with warm detergent solutions and then rinse with clean water.
- When used as recommended, CHEMGENE NaDCCTablets will not affect milk or milk products and no withdrawal period is required.
- Freshly treated udders should be carefully dried prior to milking, using disposable paper towels.

5.3 Spheres of application and the use dilutions of the product and of the active material[s] for each specific purpose according to the method by which the product is to be applied.

Applications and dilutions are covered in 5.1, 5.2 and 5.4.

5.4 Number of application times and contact times and, if necessary or applicable, all special and specific information relevant to the geographical and climatic fluctuations or necessary waiting times for the protection of human beings or animals:
Instructions for the use of CHEMGENE NaDCC in Hospitals:

Disinfection of	**Requires available chlorine of**	DILUTION RATES (DILUTE WITH CLEAN POTABLE/TAP WATER)					**Recommended contact time**
		1.08g (0.4g NaDCC)	**1.1g** (0.5g NaDCC)	**3.25g** (1.7g NaDCC)	**3.5g & 4.72g** (2.5g NaDCC)	**9.7g** (5g NaDCC)	
Body fluid spills & conditions of heavy spoiling	**10,000 ppm**	10 tablets in 250 ml	10 tablets in 300ml	10 tablets in 1 litre	7 tablets in 1 litre	9 tablets in 2.5 litres	2 minutes
Non metallic medical & veterinary appliances & laboratory discard jars	**2,500 ppm**	10 tablets in 1 litre	9 tablets in 1 litre	5 tablets in 2 litres	7 tablets in 4 litres	9 tablets in 10 litres	Overnight
General disinfection	**1,000 ppm**	10 tablets in 2.5 litres	4 tablets in 1 litre	1 tablet in 1 litre	2 tablets in 3 litres	1 tablets in 3 litres	15 minutes
W C's, drains & sinks	**400 ppm**	4 tablets per 2.5 litres	1 tablet in 750ml	2 tablets in 5 litres	1 tablet in 3.5 litres	1 tablet in 7.5 litres	Pour in solution during quiet periods
Food preparation surfaces, tiles & floors	**200 ppm**	1 tablet in 1.25 litres	1 tablet in 1.5 litres	1 tablet in 5 litres	1 tablet in 7.5 litres	1 tablet in 15 litres	Minimum 3 minutes
Baby bottle sterilisation	**125 ppm**	1 tablet in 2 litres	1 tablet in 2.4 litres	1 tablet in 8 litres	1 tablet in 12 litres	1 tablet in 24 litres	Minimum 30 minutes
Cloths & Mops	**100 ppm**	1 tablet in 2.5 litres	1 tablet in 3 litres	1 tablet in 10 litres	1 tablet in 15 litres	1 tablet in 30 litres	30 minutes (do not soak overnight)

Note: Other BIOSPOT tablet sizes can be diluted to make up the above dilution strengths (refer individual product label).

Other hospital equipment and environment applications together with method of use and times are given in reference (24).

Catering applications are:

DILUTION TABLE : CHEMGENE NaDCC 3.25g (1.7G NaDCC)			
5 Litres	200 ppm	Food preparation areas, processing equipment	---

5.5 Activity

CHEMGENE NaDCC active constituent, sodium dichloroisocyanurate has biocidal activity against the following microorganisms amongst others:

- Bacteria and Fungi
- Spores
- Mycobacteria
- Viruses

The improved biocidal capacity of CHEMGENE NaDCC tablets relative to other halogen based products is a consequence of the following factors:

A) CHEMGENE NaDCC tablets are formulated such that on dissolution in water they yield a solution with a pH in the range of approximately 5.5 to 6.0. This ensures that the more effective undissociated hypochlorous acid predominates giving a solution of optimum biocidal activity. In contrast, other halogen based products are produced in alkaline form (eg sodium hypochlorites (bleach), Halazone), having an elevated pH value, resulting in a reduced proportion of undissociated hypochlorous acid, and consequently diminished biocidal activity.

B) With sodium dichloroisocyanurate (NaDCC-Sodium dichlor-1,3,5-triazmetrione anhydrous), the active ingredient of CHEMGENE NaDCC tablets, only 50% of the total hypochlorous acid is “free” – the balance is “combined” in the form of mono or dichloroisocyanurates. The equilibrium between “free” and “combined” hypochlorous acid remains stable until a hypochlorous acid demand is placed on the sollution by microorganisms, organic matter or nitrogenous material. This demand utilises the hypochlorous acid and displaces the chemical equilibrium such that additional hypochlorous acid is generated to replenish that utilised by the hypochlorous acid demand. The existence of this equilibrium provides for the progressive and controlled release of hypochlorous acid resulting in enhanced efficiency and safety when compared with other hypochlorous acid products. As a consequence of this unique chemical equilibrium, CHEMGENE NaDCC tablets are better equipped to cope with an organic demand.

Many studies confirm the superior biocidal activity of sodium troclosene. (3,4,5,6).

Biocidal activity against a range of organisms has been reviewed by Dychdala (1) as shown in the table overleaf:

BIOCIDAL EFFECT OF FREE AVAILABLE CHLORINE ON VARIOUS ORGANISMS (1)

Organism	pH	Temp °C	Exposure Time, Min	ppm Av.Cl_2	Biocidal Results	References
ALGAE			-			
Chlorella variegata	7.8	22		2.0	Growth controlled	Palmer et al, 1955
Gomphonema parvulum	8.2	22	-	2.0	Growth controlled	Palmer et al, 1955
Microcystis aeruginosa	8.2	22	-	2.0	Growth controlled	Palmer et al, 1955
BACTERIA						
A. metalcaligenes	6.0	21	15 secs	5.0	100%	Hays et al, 1963
B. anthracis	7.2	22	120	2.3-2.4	100%	Brazis et al, 1958
B. globigii	7.2	22	120	2.5-2.6	99.99%	Brazis et al, 1958
C. botulinum toxin type A	7.0	25	30 secs	0.5	100%	Brazis et al, 1959
E. coli	7.0	20 – 25	1	0.055	100%	Butterfield et al, 1943
E. typhosia	8.5	20 – 25	1	0.1–0.29	100%	Butterfield et al, 1943
M. tuberculosis	8.4	50 – 60	30 secs	50	100%	Costigan, 1936
P. fluroescens IM	6.0	21	15 secs	5.0	100%	Hays et al, 1963
S. dysenteriae	7.0	20 –25	3	0.046–0.055	100%	Butterfield et al, 1943
S. aureus	7.2	25	30 secs	0.8	100%	Dychdala, 1960
S. faecalis	7.5	20 – 25	2	0.5	100%	Stuart et al, 1964
All vegetative bacteria	9.0	25	30 secs	0.2	100%	Snow, 1956
BACTERIOPHAGE						
S. Cremoris phage strain 144F	6.9-8.2	25	15 secs	25	100%	Hays et al, 1959
FISH						
Carassius auratus	7.9	Room	96 hours	1.0	Killed	Davis, 1934
Daphnia magna	7.9	Room	72 hours	0.5	Killed	Davis, 1934
FROGS						
Rana pipiens	8.3	21	4 days	10	100%	Kaplan, 1962
FUNGI						
A. Niger	10-11	20	30 – 60	100	100%	Dychdala, 1961
B. Rhodotorula flava	10-11	20	5	100	100%	Dychdala, 1961
NEMATODES						
C. Quadrilabiatus	6.6-7.2	25	30	95-100	93%	Chang et al, 1960
D. Nudicapitatus	6.6-7.2	25	30	95-100	97%	Chang et al, 1960
PLANTS						
Cabomba caroliniana	6.3-7.7	Room	4 days	5	100%	Zimmerman et al, 1934
	6.3-7.7	Room	4 days	5	100%	Zimmerman et al, 1934
PROTOZOA						
E. histolytica cysts	7.0	25	150	0.08-0.12	99-100%	Clarke et al, 1956
VIRUSES						
Purified adenovirus 3	8.8-9.0	25	40-50 secs	0.2	99.8%	Clarke et all, 1956
Purified Coxsackie A_2	6.9-7.1	27-29	3	0.92-1.0	99.6%	Clarke et al, 1959
Purified Coxsackie B_1	7.0	25	2	0.31-0.40	99.9%	Kelly et al, 1958

Purified Coxsackie B_5	7.0	25-28	1 30	0.21-0.30 3.25	99.9% Protected all 12 volunteers	Clarke et al, 1959
Infectious hepatitis	6.7-6.8	Room				Clarke et al, 1959
Purified poliovirus I (Mahoney)	7.0	25-28 19-25	3 10	0.21-0.30	99.9% Protected all 164 inoculated mice	Clarke et al, 1959
Purified poliovirus II (Lensen)	7.4-7.9			1.0-0.5		Clarke et al, 1959
Purified poliovirus III (Sankett)	7.0	25-28	2	0.11-0.2	99.9%	Clarke et al, 1959
Purified Theller's	6.5-7.0	25-27	5	4-6	99%	Clarke et al, 1959

5.6 Objects which must be protected: Corrosion

One of the main problems with sodium hypochlorite (NaOCl) disinfectants is that they tarnish or corrode many metals because in NaOCl solutions all the available chlorine (av.Cl) is free. However, in sodium dichloroisocyanurate (NaDCC) solutions an equilibrium exists between free av.Cl (50%) and bound av.Cl (50%). Hence, NaDCC solutions are less corrosive.

In order to investigate this possibility, standardised strips of six metal: mild steel, galvanised mild steel, stainless steel 316, copper, aluminium and brass, were immersed for 4 periods of 25 h in either tap water, aqueous solutions of NaOCl (Chloros: Imperial Chemical Industries) containing 5, 125 and 1,000 ppm av.Cl, or aqueous solutions of NaDCC (CHEMGENE NaDCC) containing 5, 125 and 1,000 ppm av.Cl. Four parameters were recorded before and after each immersion: available chlorine content of solutions, pH of solutions, weight of metal strips, and the degree of tarnishing or corrosion of the strips.

The metals were found to vary markedly in their resistance to tarnishing and corrosion. Stainless steel 316 was unaffected by 100 h immersion; aluminium and brass were tarnished but not corroded; galvanised mild steel and copper were tarnished by NaDCC and moderately corroded by NaOCl; whilst mild steel was heavily tarnished by NaDCC and heavily corroded by NaOCl. With the exception of brass all the metals were much more tarnished or corroded by NaOCl than by NaDCC.

It is concluded that for most metals NaDCC solutions cause less tarnishing or corrosion than NaOCl solutions of the same strength. (7)

SUMMARY OF TARNISHING/CORROSION FINDINGS

IMMERSION	METAL	WATER	BIOSPOT (ppm av.Cl)			CHLOROS (ppm av.Cl)		
			5	125	1000	5	125	1000
First	Mild Steel	-	-	++	+++	+	+++	++++
	Galvanized Mild Steel	+	+	+	+	+	+	++
	Copper	-	+	+	++	+	+	+++
	Brass	-	-	-	++	-	-	+
	Aluminium	-	-	-	-	-	+	++
	Stainless Steel 316	-	-	-	-	-	-	-
Second	Mild Steel	+++	+++	+++	+++	+++	+++	+++++
	Galvanized Mild Steel	+	+	+	+	++	++	+++
	Copper	-	+	++	++	+	+++	++++
	Brass	-	-	+	+++	-	-	++
	Aluminium	-	-	+	-	+	++	+++
	Stainless Steel 316	-	-	-	-	-	-	-
Third	Mild Steel	+++	+++	+++	+++	+++	+++	+++++
	Galvanized Mild Steel	+	+	+	+	++	++	++++
	Copper	-	+	++	++	+	+++	++++
	Brass	-	-	+	+++	-	-	++
	Aluminium	+	-	+	+	+	++	+++
	Stainless Steel 316	-	-	-	-	-	-	-
Fourth	Mild Steel	+++	+++	+++	+++	+++	+++	++++++
	Galvanized Mild Steel	+	+	+	+	++	++	+++++
	Copper	+	++	++	+++	++	++++	+++++
	Brass	-	-	+	+++	-	-	++
	Aluminium	+	-	+	+	+	++	+++
	Stainless Steel 316	-	-	-	-	-	-	-

Key

-	No effect
+	Mild tarnishing
++	Moderate tarnishing
+++	Pronounced tarnishing
++++	Mild corrosion
+++++	Moderate corrosion
++++++	Pronounced corrosion

LOW CORROSION CHARACTERISTICS

The results for the different metals submerged in 1000 ppm available chlorine solution for 4 periods of 25 hours extracted from the previous table are:

METAL	WATER	ECT RATED 1000PPM/L	SODIUM HYPO
MILD STEEL	+++	+++	++++++
GALV. MILD STEEL	+	+	+++++
COPPER	+	+	+++++
BRASS	-	+++	++
ALUMINIUM	+	+	+++
STAINLESS STEEL 316	-	-	-

KEY:
-NO EFFECT
+MILD TARNISHING
++MODERATE TARNISHING
+++PRONOUNCED TARNISHING
++++MILD CORROSION
+++++MODERATE CORROSION
++++++PRONOUNCED CORROSION

5.7 Effects/Influences on target organisms

Physiological chemistry has been used to determine the manner in which chlorine exercises its bactericidal action. It has been found that the trace level at which chlorine is effective implies that it must inhibit a key enzymatic process.

This process is determined to be the oxidation of glucose by the bacterial cell; once the power of glucose oxidation is lost, the bacterial cells die – the suspension becomes sterile. The reaction is not reversible; that is, that bacteria once inactivated by chlorine cannot be reactivated (22).

5.8 Method of Activity

Already covered in 5.7.

5.9 User Information

This information has been already provided on 5.2 guidance for the use of the product and on point 9 Material Safety Data Sheet,

5.10 Claims on the product label and details of the effectiveness of the product to justify these claims, including possible standard test protocols used, laboratory testing or, according to the circumstances, in vivo or in situ trials undertaken.

The biocidal activity of hypochlorous acid has been well estabilished. The following tables provide evidence of its effectiveness against a range of frequently encountered water-borne pathogens.

BACTERIA

Effectiveness of hypochlorous acid (free available chorine) against a range of water-borne bacteria.						
ORGANISM	PH	TEMP °C	EXPOSURE TIME	AVAILABLE CHLORINE mgs/litre	BIOCIDAL RESULT	REF
Campylobacter jejuni	8.0	4	1 min	0.1	>99.9%	9
Escherichia coli	7.0	20-25	1 min	0.055	100%	1
Salmonella dysenteriae	7.0	20-25	3 mins	0.055	100%	1

The mycobactericidal activity of CHEMGENE NaDCC was proved under clean and dirty conditions using a quantitative suspension test. The results found are as follows:

MYCOBACTERIA Time taken (mins) to achieve a $\log_{10}$ Reduction > 5					
	1000 ppm clean conditions	1000 ppm dirty conditions (10% horse serum)	10000 ppm clean conditions	10000 ppm dirty conditions (10% horse serum)	REF
M. chelonae	1	1	1	1	45
M. chelonae epping	4	60	1	1	45
M. fortuitum NCTC 10394	10	10	1	1	45
M. tuberculosis H37 Rv	1	4	1	1	45
M. avium-intracellulare (MAI) -clinical isolate-	60	60	1	10	45

Comparative tests using different type of disinfectants against mycobacteria have led to recommend NaDCC as the best disinfectant for water treatment and pipework. (45)

Independent tests carried out with Hydrachem NaDCC tablets against other important water-borne pathogens at Public Health Laboratory Service (PHLS) has shown the following results (14); the report includes the test protocol used.

BACTERICIDAL ACTIVITY OF CHEMGENE NaDCC

ORGANISM	PH	TEMP °C	EXPOSURE TIME*	AVAILABLE CHLORINE	BIOCIDAL RESULT
Salmonella Typhi	7.4	22.5	30 min	14.8 approx	>99.9%
Vibrio Chlolerae	7.4	22.5	30 min	14.8 approx	>99.9%
S Sonnei	7.4	22.5	30 min	14.8 approx	>99.9%
S Faecalis	7.4	22.5	30 min	14.8 approx	>99.9%
E Coli	7.4	22.5	30 min	14.8 approx	>99.9%

**The 30 minutes exposure time was part of the procedure followed to carry out this test in order to allow enough time for disinfection to occur. It does not necessarily reflect the time to eradicate the bacteria.*

Further tests were carried out using 3 strains of Methicillin Resistant Staphylococcus Aureus (16). The results proved that CHEMGENE NaDCC dissolved in water and diluted to a strength of 1000 ppm available chlorine achieved a >6 lg_{10} kill of all 3 test strains in 2 minutes under both clean conditions and in the presence of 5% horse serum.

EFFECTIVENESS OF CHEMGENE NaDCC AGAINST 3 STRAINS OF METHICILLIN RESISTANT STAPHYLOCOCCUS AUREUS UNDER CLEAN CONDITIONS					
MRSA STRAIN	AV CHLORINE	TEMP °C	EXPOSURE TIME	REDUCTION	REF
Epidemic Strain 15 (PHLS)	1000 ppm	20	2 mins	>99.9%	16
Fresh Clinical isolate (Preston PHL)	1000 ppm	20	2 mins	>99.9%	16
NCTC 12493	1000 ppm	20	2 mins	>99.9%	16

EFFECTIVENESS OF CHEMGENE NaDCC AGAINST 3 STRAINS OF METHICILLIN RESISTANT STAPHYLOCOCCUS AUREUS UNDER DIRTY CONDITIONS (5 % HORSE SERUM)					
MRSA STRAIN	AV CHLORINE	TEMP °C	EXPOSURE TIME	REDUCTION	REF
Epidemic Strain 15 (PHLS)	1000 ppm	20	2 mins	>99.9%	16
Fresh Clinical isolate (Preston PHL)	1000 ppm	20	2 mins	>99.9%	16
NCTC 12493	1000 ppm	20	2 mins	>99.9%	16

Recent tests have been carried out by an independent laboratory using CHEMGENE NaDCC effervescent tablets (13). The results are shown in the following tables:

EFFECTIVENESS OF CHEMGENE NaDCC AGAINST BACTERIA USING A MODIFICATION OF EN 1040 UNDER CLEAN CONDITIONS		
Bacteria	Av Chlorine	Reduction
Bordetella bronchiseptica	2.8 ppm	>99.9%
Enterobacter cloacae	2.8 ppm	>99.9%
Erysipelothrix rhuspathie	2.8 ppm	>99.9%
Listeria monocytogenes	2.8 ppm	>99.9%
Pasteurella multicoda	2.8 ppm	>99.9%
Pseudomonas aeruginosa	2.8 ppm	>99.9%
Yersinnia enterolytica	2.8 ppm	>99.9%
Candida albicans	2.8 ppm	>99.9%

EFFECTIVENESS OF CHEMGENE NaDCC AGAINST BACTERIA USING A MODIFICATION OF EN 1040 UNDER DIRTY CONDITIONS (50% BOVINE SERUM)		
Bacteria	Av Chlorine	Reduction
Bordetella bronchiseptica	1100 ppm	>99.9%
Enterobacter cloacae	1100 ppm	>99.9%
Erysipelothrix rhuspathie	1100 ppm	>99.9%
Listeria monocytogenes	1100 ppm	>99.9%
Pasteurella multicoda	1100 ppm	>99.9%
Pseudomonas aeruginosa	1100 ppm	>99.9%
Yersinnia enterolytica	1100 ppm	>99.9%
Candida albicans	1100 ppm	>99.9%

EFFECTIVENESS OF CHEMGENE NaDCC AGAINST BACTERIA USING BS EN 1276 UNDER CLEAN CONDITIONS				
BACTERIA	AV CHLORINE	TEMP °C	EXPOSURE TIME	REDUCTION
Pseudomonas aeruginosa	110 ppm	20	5 mins	>99.9%
Escherichia coli	110 ppm	20	5 mins	>99.9%
Staphylococcus aureus	110 ppm	20	5 mins	>99.9%
Enterococcus hirae	110 ppm	20	5 mins	>99.9%

EFFECTIVENESS OF CHEMGENE NaDCC AGAINST BACTERIA USING BS EN 1276 UNDER DIRTY				
BACTERIA	CONDITIOAV NS CHLORINE	TEMP(3g/l bo °C	vine EXPOSUREalbumin) TIME	REDUCTION
Pseudomonas aeruginosa	500 ppm	20	5 mins	>99.9%
Escherichia coli	500 ppm	20	5 mins	>99.9%
Staphylococcus aureus	500 ppm	20	5 mins	>99.9%
Enterococcus hirae	500 ppm	20	5 mins	>99.9%

VIRUSES

Effectiveness of hypochlorous acid (free available chorine) against a range of water borne viruses						
ORGANISM	PH	TEMP °C	EXPOSURE TIME	AVAILABLE CHLORINE mgs/litre	BIOCIDAL RESULT	REF
Adenovirus (type 3)	7.8	22	5 mins	0.5	>99.9%	10
Enteroviruses:						
Poliovirus (type 1)	7.8	22	5 mins	0.5	>99.9%	10
Coxsackievirus (type A9)	7.8	22	5 mins	0.5	>99.9%	10
Coxsackievirus (type B5)	6.0	5	13.2 mins	0.5	>99.9%	27
Coliphages MS2	6.0	5	1.2 mins	0.5	>99.9%	27
Coliphages 0X174	6.0	5	0.5 mins	0.5	>99.9%	27
Echovirus (type 7)	7.8	22	5 mins	0.5	>99.9%	10
Reovirus (type 3)	7.8	22	5 mins	0.5	>99.9%	10
Hepatitis A	7.0	5	3.6 mins	0.5	>99.9%	11
Infectious hepatitis	6.8	Room	30 mins	3.25	Protected all 12 volunteers	1
Simian rotavirus SAII	6.0	5	15 secs	0.11-0.67	100%	12

TOXICITY AND VIRUS TESTS ON CHEMGENE NaDCC CHLORINE TABLET

ORGANISM	TEST STANDARD	TEMP °C	EXP TIME	AVAILABLE CHLORINE mgs/litre	BIOCIDAL RESULT	REF
Avian Influenza	UK MAFF	4	30 mins	333	>99.9%	38
Newcastle Disease	UK MAFF	4	30 mins	700	>99.9%	38
Infectious Bursal Disease	UK MAFF	4	30 mins	500	>99.9%	38
Laryngo-tracheitis infection	UK MAFF	4	30 mins	700	>99.9%	38
Avipox virus	UK MAFF	4	30 mins	700	>99.9%	38
Foot and mouth disease virus	UK MAFF	4	30 mins	354	>99.9%	39
Swine vesicular disease virus	UK MAFF	4	30 mins	709	>99.9%	39

ALGAE AND FUNGI

Fungi can present a health hazard by the water-borne route. Algae growth can be controlled by the use of CHEMGENE NaDCC, to prevent fouling of systems and slime build-up. The effectiveness of chlorine against a range of these agents is given below:

ORGANISM (FUNGI)	PH	TEMP °C	EXPOSURE TIME	PPM AV.CL.	BIOCIDAL RESULT	REF
Aspergillus fumigatus conidia	7.0	23-27	10 mins	10	100%	15
Aspergillus niger conidia	7.0	23-27	60 mins	3	100%	15
Cladosporium sp. Conidia	7.0	23-27	30 mins	2	100%	15
Cryptococcus laurentii cells	7.0	23-27	10 mins	2	100%	15
Rhodotorula glutinis cells	7.0	23-27	30 mins	2	100%	15
Rhodotorula rubra cells	7.0	23-27	30 mins	2	100%	15

ORGANISM (ALGAE)	PH	TEMP °C	EXPOSURE TIME	PPM AV.CL.	BIOCIDAL RESULT	REF
Chlorella varigata	7.8	22	-	2	Growth controlled	1
Gomphonema parvulum	8.2	22	-	2	Growth controlled	1
Microcystis aeruginosa	8.2	22	-	2	Growth controlled	1

Recent tests have been carried out by an independent laboratory using CHEMGENE NaDCC effervescent tablets (13). The results are shown in the following tables:

EFFECTIVENESS OF CHEMGENE NaDCC AGAINST BACTERIA USING BS EN 1650 UNDER CLEAN CONDITIONS				
FUNGAL STRAIN	AV CHLORINE	TEMP °C	EXPOSURE TIME	REDUCTION
Candida albicans	200 ppm	20	30 mins	>99.9%
Aspergillus niger	200 ppm	20	30 mins	>99.9%

EFFECTIVENESS OF CHEMGENE NaDCC AGAINST BACTERIA USING BS EN 1650				
FUNGAL STRAINUNDE	R DIRTYAV COND CHLORINE	ITIONSTEMP (°C	).3g/lEXPOSURE ›ovine albumi n TIME	REDUCTION
Candida albicans	2000 ppm	20	30 mins	>99.9%
Aspergillus niger	2000 ppm	20	30 mins	>99.9%

PROTOZOA

Effectiveness of hypochlorous acid (free available chorine) against a range of protozoan cysts.						
ORGANISM	PH	TEMP °C	EXPOSURE TIME	AVAILABLE CHLORINE mgs/litre	BIOCIDAL RESULT	REF
Entamoeba histolyitica cysts	5.0	30	10 mins	2	99.9%	17
Giardia lamblia cysts	6.0	15	10 mins	3	100%	18
Naegleria fowleri	7.3	25	15 mins	2	100%	19

Note: Not effective against Cryptosporidium. Boiling water recommended.

A comparative study of the antibacterial properties of sodium dichloroisocyanurate effervescent tablets and sodium hypochlorite formulations (3) has shown the higher activity of sodium dichloroisocyanurate (NaDCC) against a range of organisms compare to sodium hypochlorite.

From the same investigation it can be concluded overall that sodium dichloroisocyanurate (NaDCC) effervescent tablet has a high disinfection capacity against a wide range of organisms and it should represent adequate safety margins for disinfection of infant feeding utensils under normal use.

In another study, (20) solutions prepared from effervescent tablets of sodium dichloroisocyanurate (NaDCC) have shown to be effective for the sterilisation of infant feeding bottles and teats. Solutions containing not less than 125 ppm available chlorine have been recommended for this purpose. It was also proved that the NaDCC solution retains a bactericidal capacity of more than 10^8 organisms/ml even in the presence of 2% milk which should be well in excess of that required under "in use" conditions.

Results from an independent laboratory, (21) have shown that reduction of microrganisms after washing in 100 ppm of available chlorine for 10 minutes. Lettuce, cucumber and tomato unwashed, washed in tap water, soaked in sodium hypochlorite and soaked in CHEMGENE NaDCC were tested. Reductions from a high of 210,000 TPC (total plate count) on unwashed lettuce to less than 100 TPC soaked in BIOSPOT solution and from a high of 16,000 TPC on unwashed cucumber which also had Listeria present to less than 100 TPC and no Listeria soaked in CHEMGENE NaDCC solution were recorded.

Significantly, although washing in water reduced the TPC it did not remove Listeria.

INDEPENDENT BACTERIOLOGICAL RESULTS TPC AFTER 24/48 HOURS				
SAMPLE	**NOT WASHED**	**WASHED WATER**	**SOAKED 30 MINS 200 ppm (NaOCl) sodium hypochlorite**	**SOAKED 10 MINS 100 ppm (NaDCC) BIOSPOT**
LETTUCE				
1	80000/86000	1900/2200	<100/<100	<100/<100
2	120000/140000	4300/4900	<100/<100	<100/<100
3	210000/240000	1900/2400	600/800	<100/<100
4	70000/110000	1400/1600	400/400	<100/<100
TOMATO				
1	1200/1300	100/100	<100/<100	<100/<100
2	500/600	<100/<100	<100/<100	<100/<100
3	1900/2200	300/400	<100/<100	<100/<100
4	4300/4900	<100/<100	<100/<100	<100/<100
CUCUMBER				
1	1600/2000	2900/3600	200/200	<100/<100
2	14000/16000	2600/4000	<100/<100	<100/<100
3	400/1100	500/600	<100/<100	<100/<100
4	1100/1900	800/1100	<100/<100	<100/<100

The effect of Sodium Dichloroisocyanurate (NaDCC) on the activity of DNA polymerase (DNA-P) associated with hepatitis B virus in serum was evaluated by the "Servicio of Microbiologia" in Barcelona, Spain (25), using In-vitro test. DNA-P positive and negative stock virus. Inhibition of DNA-P activity by NaDCC was found to be concentration dependent.

The same team has tested the antiviral activity of NaDCC against human immunodeficiency virus type 1 (HIV-1) using a quantitative suspension test method (26).

The results have shown:

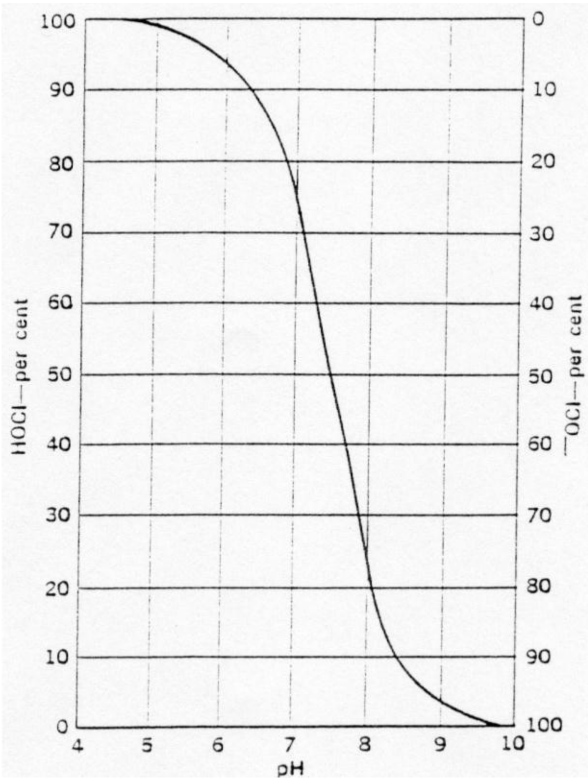
Organism	Av. Chlorine	Time	Inactivation
HBV	1000 ppm	2 minutes	100%
HIV-1	100-120 ppm	5 minutes	100%

There have been extensive studies relating to these cases, which support the above finding. References (30,31,32,33).

The virucidal efficiency of free chlorine in water against enteric viruses is shown in Appendix 1. (28,29) Also see effectiveness of hypochlorous acid against a range of waterborne viruses.

5.11 Limitations of Effectiveness

Germicidal effectiveness will largely depend on the concentration of undissociated hypochorous acid in water solution and the relationship between pH and the degree of dissociation of HOCl as shown in the following graph:

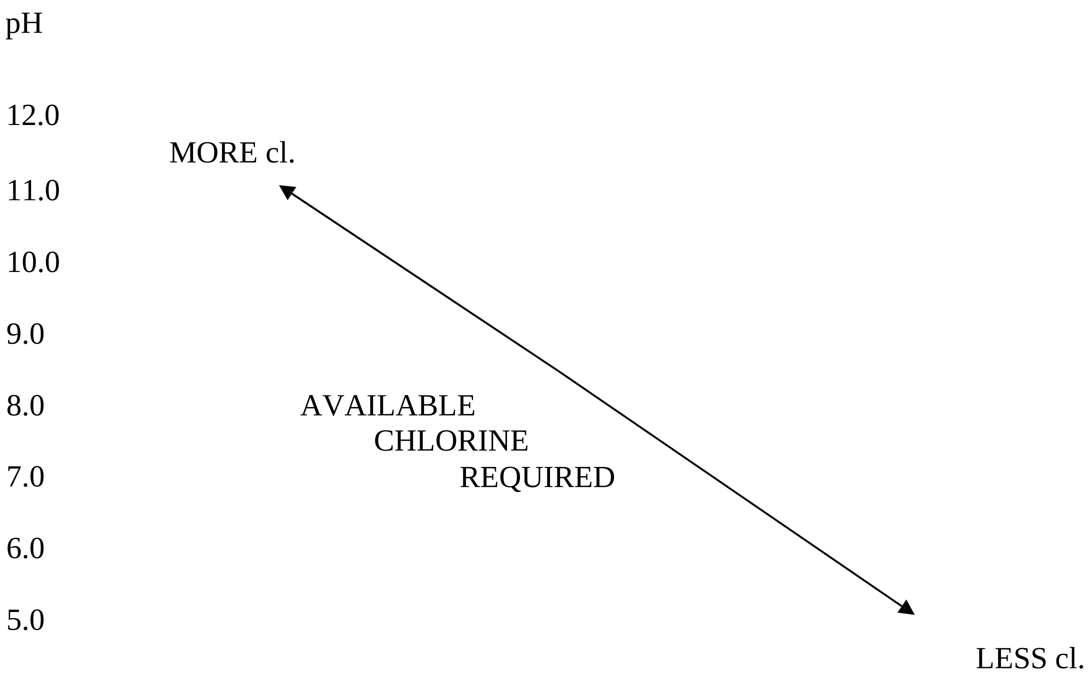


Relationships among HOCl, -OCl, and pH, (After Baker, 1959.) from Chlorine and chlorine compounds, G.R. Dychdala, B.S. (1) Studies carried out by several scientists have shown that the bactericidal and virucidal activity of NaOCL solution were affected by the pH. In addition to pH, various other environmental factors, alone or in combination, will determine the antimicrobial action of chlorine:

- Temperature
- Organic material
- Hardness
- Addition of Ammonia or Amino compounds
- Surfactants.

They attributed the striking changes in killing to changes in concentrations of undissociated hypochlorous acid and concluded that the concentration of HOCl is closely related to the speed of kill by hypochlorites solution. (1)

pH AFFECTS PERFORMANCE



The amount of chlorine required to kill the same amount of bacteria dramatically increases if the pH is high.

Liquid bleach if 9.0 – 12.0 pH

Chlorine tablets are c6.0 – 6.5 pH

<u>Effect of Temperature</u>

The effect of temperature was demonstrated by (Ostigan (1936)) on Hycobacterium Turberculosis and Rudolph et al. (1941). These workers observed a 60 to 65% reduction in killing time with a 10°C rise in temperature. Later, Weber et al. (1944), in other related work with hypochlorite solutions at 25 ppm available chlorine and three different pH levels (pH=10, pH=7 and pH=5), concluded that a rise of 10°C produced a reduction of 50 to 60% in killing time, and that a drop of 10°C increased the necessary exposure time by about 2.1 to 2.3 times. (1)

Effect of Temperature on Lethal Activity of Hypochlorite Solutions from the Halogens, J.R.Trueman ( )					
Data of	Avalable chlorine (ppm)	Temp (°C)	Time for Effective kill of bacteria (min)	PH	Increase in lethal activity per 10°C rise %
Rudolph and Lovine (1941) (Using B. metiens spores)	25 25 25 25	20 30 35 50	121 65 39 9	10 10 10 10	--- 46 80 51
Weber and Lovine (1944) (Using B.metiens spores)	25 25 25	0-30 0-30 20-50	10-1.2 12.9-1.4 570-46	5 7 10	50 52 57
Allen (1950) after Butterfield et al. (1943) (Using E.coli)	0.03 0.03 0.07 0.07 0.40 0.40 0.75 0.75	2-5 20-25 2-5 20-25 2-5 20-25 2-5 20-25	5 3 10 5 11 3 20 3	7 7 8.5 8.5 9.8 9.8 10.7 10.7	Approx. 20 Approx. 25 approx. 36
Collins (1955) (Using a Pseudomonad)	3 3	4.4 21	10 4	-- --	-- 35

The data in this table shows a general increase in activity for 10°C rise in temperature, of between 50-60% for spores, and rather less for vegetative bacteria. It can also be seen that the effect of temperature is rather more marked at higher pH values, particularly with the vegetative organisms.

In considering stability of the diluted solutions, it has been found that although a rise in temperature increase the germicidal activity, it does not result in loss of available chlrine. Hadfield (1954) recorded that solutions of sodium hypochlorite could be kept at 55°C for up to 3 hours without any loss in available chlorine.

Effect of Organic Material

Organic material in chlorine solution consumes available chlorine and reduces its capacity for bactericidal activity; this is evident especially in solutions with low levels of chlorine.

If the organic matter contains proteins, the chlorine reacts and forms chloramines, retaining some of its antibacterial activity, even though the available chlorine levels are reduced considerably.

It appears that sugars and starches do not affect the germicidal activity of chlorine. Shere (1948) reported that 500 ppm of alkyl aryl sulfonate did not exhibit any slowing action on the germicidal effectiveness of the hypochlorite solutions. Other organic materials such as tyrosine, tryptophan, cystine, egg albumin, peptone, body fluids, tissues, microbes, and vegetable matter when present in a sanitizing solution, will consume chlorine to satisfy the organic water demand; in this case, the chlorine may lose its function as a germicidal agent unless it forms chloramines or unless the chlorine dosage is adjusted to overcome this demand. This loss of chlorine due to organic matter may be significant in cases in which minute amounts of chlorine are employed. Higher levels of chlorine, however, tend to produce a safety reserve for performing the desired bactericidal action. (1)

In the presence of organic matter, more concentrated solutions are required, to compensate for the available chlorine used in breaking down or reactivity with the soiling material. In situations where organisms are protected by an organic barrier, hypochlorite disinfectants have a considerable advantage due to their ability to attack and penetrate the barrier, forming a dispersion, in which the infecting organisms can be reached and kill. (2)

Using horse serum, it has been shown (Coates, 1988a) that the degree of neutralisation of both NaOCl and NaDCC disinfectants is directly proportional to the concentration of serum present. However, the degree of neutralisation of NaOCl disinfectants and the disparity increases with the concentration of serum. Hence, where there is a high concentration of organic material present, NaDCC will be very much more effective with NaOCl (see table overleaf).

ppm av. Cl required to achieve a 5 log^{10} reduction of
Pseudomonas aeruginosa in two minutes at 25°C (Coates, 1988a)

% Serum	NaDCC		NaOCl
0	5	5	
1	90	100	
2	200	180	
10	1,100		2,700
20	x		12,000
30	4,000		17,000
40	x		20,000
50	6,250		x
70	10,000		x

A comparison made of the activity against Pseudomonas aeruginosa of sodium hypochlrite (NaOCl) and sodium dichoroisocyanurate (NaDCC) solutions containing 0-40% and 0-70% horse serum respectively. The degree of inactivation of NaOCl and of NaDCC solutions by different concentrations of horse serum is expressed in terms of a neutralization coefficient (figs), which demonstrate that NaDCC solutions are less prone to inactivation by serum than are NaOCl solutions, the dsiparity diverging as serum concentration is increased. In 30% serum and NaDCC solution containing 4000 ppm of available chlorine exhibited similar bactericidal activity to an NaOCl solution containing 17,000 ppm available chlorine (Coates, 1987).

Effect of Hardness

The calcium and magnesium ions in hard water do not inactivate chlorine disinfectants but ferrous or manganous cations, and nitrite or sulphide anions reduce active hypochlorous acid to inactive chloride. Small amounts of potassium bromide may potentiate the action of hypochlorite (Shere et al, 1962).

Effect of Addition of Ammonia or Amino Compounds

The bactericidal activity of free chlorine is considerably diminished when chlorine is added to water containing ammonia or amino compounds.

Weber et al (1944) concluded that if the ammonia concentration is less than one eighth of the total available chlorine added, the ammonia will be destroyed and the excess chlorine will remain as free available chlorine, exhibiting fast bactericidal action. However, if the concentration of ammonia is greater than one fourth that of free chlorine, the available chlorine will exist in the form of chloramines and thus will be slow in bactericidal activity. Water temperature has an effect on the antibacterial action of the ammonia-chlorine treatment, the efficiency decreasing with lowering of the temperature. (1)

Surfactants

Small amounts (1 to5%) of dodecylbenzene sodium sulphonate may be incorporated into products, but non-ionic surfactants generally should be avoided because they will react rapidly and decompose the chloroisocyanurates (Industrial uses of ACL, 1979; Thompson, 1964) (1)

Organisms resistant to Chlorine

Various types of bacteria, viruses, fungi and algae exhibit different resistance to hypochlorites under diverse practical conditions. This selective resistance of organisms to chlorine may be compensated for either by increased concentration, by lowering of pH, or by raising of temperature. Tonney et al. (1928 and 1930), found that vegetable cells are less resistant to chlorine than the spore-forming group, and that 0.15 to 0.25 ppm available chlorine was sufficient to destroy the vegetative group within 30 seconds. The spore-forming organisms were about 10 to 1000 times more resistant to chlorine than vegetative forms. Phillips (1952), in comparing the relative resistance of spores versus vegetative bacterial organisms, attributed this resistance of spores to changes in molecular configuration of proteins protecting the sulfhydryl groups of essential enzymes, whereas in the case of vegetative forms, these groups seemed to be unprotected. Clarke et al. (1954, 1959) disclosed that some viruses, being more resistant to chlorine, would require considerably higher chlorine levels to inactivate them. Working with Aspergillus niger and Trichophyton rosaceum, Costigan (1931, 1941) showed that mold spores are considerably more resistant to chlorine and that 135 to 500 ppm of hypochlorite solution was necessary to inactivate a high density of spores in several minutes (1).

6. TOXICOLOGICAL STUDIES

6.1 Acute toxicity

6.1.1 Oral

Dichloroisocyanurates are considered no more than slightly toxic when administered as single oral doses in rats. The LD_{50} values range from 600 to 1520 mg/kg (37).

Concentrated sodium dichloroisocyanurate causes gastrointestinal irritancy and is therefore likely to be more toxic orally than the diluted material.

When diluted to 10% or below in water, oral LD_{50}s are rat 740 mg/kg, rabbit 2000=2500 mg/kg, mouse 1230 mg/kg.

The oral human LDLO, lethal dose low = 3570 mg/kg

The oral LD_{50}s of cyanuric acid to rats and mice were 7700 and 3400 mg/kg , rats survived doses of up to 10,000 mg/kg with only slight or negligible toxic effects.

Sodium cyanurate was administered to rats and mice in drinking water at concentrations up to 5375 ppm, the daily compound consumption was 500-700 mg/kg for rats and 2000-2200 mg/kg for mice. In a few male rats and mice on the highest dose, bladder calculi and accompanying hyperplasia were noted.

In a 2 year study on rats, the no-effect level during the first 12 months of sodium cyanurate administration in the drinking water was 2400 ppm (average daily compound consumption 145 mg.kg (males) 266 mg/kg (females)). During the last 12 months, the no effect level was 5375 ppm (371 mg/kg (males) 634 mg/kg (females)).

6.1.2 Dermal

In undiluted form, sodium dichloroisocyanurate is corrosive to moist skin and eyes and causes severe irritation. Undiluted sodium dichloroisocyanurate dihydrate is also a severe irritant to rabbit eyes. Sodium dichloroisocyanurate diluted to 5% in water did not cause skin irritation or sensitisation to humans. A 2% solution applied to rabbit eyes caused moderate irritation.

6.1.3 Inhalation

Sodium dichloroisocyanurate is moderately toxic when inhaled, delayed death resulting in 4 out of 10 rats inhaling 200 mg/1 of fine powder for 1 hour, thought similar nose-only exposure to coarse powder caused no deaths. A 4-week inhalation study in which rats inhaled the sodium salt at 32.8 mg/m^3 for 6 hours/day, 5 days/week produced no remarkable pathology. Reduction in body weight gain was the only significant finding .

Several inhalation studies have been conducted with rats exposed to chlorinated isocyanurate dust . In these studies, groups of 10 male and female CD rats were exposed separately to dichloroisocyanurate dust an analytical exposure levels of approximately 3, 10 and 30 mg/m^3 for 6hr/day, 5 days/week for a total of 4 weeks.

No mortality occurred in test animals in these studies. Adverse reactions were observed in mid and particularly high dose animals during the exposure period and included moist rales, nasal discharge, excess salivation, lacrimation and laboured breathing.

The lower exposure concentration of $3mg/m^3$ was considered a no-effect level. This dose was calculated by assuming that total volume of air inspired by a rat over a 6 hour exposure period is $0.086m^3$. The comparable dose administered to a man (total volume of air inspired over 8 hours is $10.4m^3$) exposed to $0.5mg/m^3$ of chlorinated isocyanurate dust (a nonimitating level based on Monsanto workplace experience) can be estimated to be about 0.07 mg/kg. This level is lower by a factor 08 than the no-effect exposure level in the rat (34).

6.2 Irritability of the skin and eyes.

Data collected in the Sax's Dangerous properties of Industrial Material (35) shows the following results:

Skin Irritation

Skin Rabbit: 500mg/34 hours well defined erythema and slight edema.

Skin Rabbit 500mg/72 hours severe erythema (beet redness) to slight eschar formation (injuries in dept) and severe edema (raised more than 1 mm and extending beyond area of exposure).

Eye Rabbit 10mg/34 hours severe.

Sodium dichlorocyanurate in the dry form is not appreciably irritating to dry skin. However, when moist, the concentrated material is irritating to skin and also may cause severe eye irritation.

Cyanuric acid at concentrations of up to 8% in water did not cause skin or eye irritation (34) and no cases of dermatitis have been reported among exposed workers.

Rabbits were unaffected by 5ml of 0.8% aqueous suspension dermally on 5 days/week for 3 months; higher concentrations caused slight kidney damage.

6.3 Dermal Sensitivity

Not applicable.

6.4 Information regarding absorption by the skin.

Not applicable.

6.5 Available toxicological details regarding the inactive substances.

Adipic Acid

GENERAL STATEMENT

In the USA, adipic acid is classified "Generally Recognised as Safe" by the Food and Drug Administration and finds use in food starches and jellies.

Adipic acid is listed in the US Food Chemicals Codex as a Food Acidulant.

Adipic acid dust can irritate eyes, mucous membranes and skin, the latter especially in the presence of moisture e.g. perspiration. Prolonged contact with dust, vapour or aqueous solutions (especially when hot) should be avoided.

Adipic acid has not undergone an assessment of either skin or eye irritancy according to OECD protocol and the only information available is derived from sources in the public domain.

Specifically, adipic acid is reputed to produce severe eye irritation in rabbits following the administration of 20mg over a 24 hour period. This reference is cited in the Registry of Toxic Effects of Chemical Substances, NIOSH 1978.

It is appropriate to note that adipic acid is identified as an eye irritant in the context of the EEC Dangerous Substances Directive 67/548 and is listed in annex 1 of the Directive with risk phrase R36 "irritating to the eyes".

SPECIFIC TOXICITY

Experience on humans: prolonged contact can lead to a drying out of the skin.

LD_{50} oral (rat): ca. 5700mg/kg
LC_{50} inhalation (rat): > 7.7mg/1/4 hour

Primary skin irritation (rabbit): non-irritant
Primary mucous membrane irritation (rabbit eye): irritant.

Acute inhalation hazard (rat): test results dependent on toxicity and volatility): no deaths occurred after 8 hours exposure to an atmosphere saturated with the substance at 20°C.

Sodium Bicarbonate

GENERAL STATEMENT

Sodium bicarbonate is a substance of low toxicity widely used in food and medicine. It should be treated as a low toxicity dust. (Recommended occupational exposure limit (unlisted HSE) 10mg/m^3 – 8 hour TWA total dust, 5mg/m^3 8 hour TWA respirable dust).

SPECIFIC TOXICITY

Ingestion: practically non-harmful. Oral rat LD_{50} 4220 mg/kg.

Skin and eye irritation: sodium bicarbonate is not regarded as constituting a hazard to the skin or eyes. The information that has been referenced in support of this judgement was reported by Laberco Laboratories in 1972, Hudson Laboratories in 1972 and Murphy et al in 1982. The responses observed in these studies included slight conjunctivitis that persisted for up to seven days without any iridial or conrneal involvement. All three investigators concluded that sodium bicarbonate was non irritant to the eyes.

Two studies have been reported assessing the skin irritation potential of sodium bicarbonate. The method used in these studies was that of Draize et al (1944) which employs a 24 hour contact with abraded and intact rabbit skin. Although this method does not comply completely with current EEC requirements, it may be regarded as being more stringent than the EEC test method. By this method, Laberco Laboratories and Hudson Laboratories found that sodium bicarbonate was not irritant to the skin.

6.6 Information regarding the exposure of man and of the user to the biocidal product.

The absence of significant cyanurate-induced effects via a variety of studies designed to measure different toxic endpoints, indicates that there is a substantial margin of safety for human exposure to cyanurate in our recommended CHEMGENE NaDCC applications.

1. From the published literature, (e.g. A review of Toxicology Studies on Cyanurate & Its Chlorinated Derivatives. Hammond et al **Environmental Health Perspectives** vol 69 pp. 287-292, 1986), there are many findings from acute, subchronic, reproduction, matabolism, mutagenicity and chlronic/carcinogenicity tests on cyanurate.

2. Cyanuric acid is practically non toxic when administered as a single oral or dermal dose (Rat oral LD_{50} > 10,000 mg/Kg: Rabbit dermal LD_{50} > 7940 mg/Kg).

3. In a series of metabolic studies, cyanurate has been shown to be readily eliminated from the body unchanged.

   (Barbee et al }Toxicologist 3:80 1983; }Inokuchi et al Eisei Kagaku 24: 49-59 1978
   }Toxicologist 4: 92 1984 }

   The findings appeared to be applicable to humans, since cyanurate was found to be rapidly and quantitatively eliminated unchanged in urine following oral ingestion by volunteers (Allen et al Drug. Metab. Rev. 13: 499-516 1982)

4. From Teratology studies it was concluded that sodium cyanurate was not foetotoxic or teratogenic (FMC studies & Cascieri et al Toxicologist 3: 65 1983).

5. From reproductive studies, it was concluded that sodium cyanurate did not interfere with reproductive performance in the rat when administered throughout 3 consecutive generations (Wheeler et al Toxicologist 5: 189 1985).

6. In mutagenicity studies with sodium cyanurate, there was no evidence of cyanurate-induced chromosomal aberrations in rat bone marrow cells (Hammond et al Fundam Appl. Toxicol. 5 655-664 1985).

7. Subchronic toxicity studies of sodium cyanurate demonstrated that there was no evidence of compound-related clinical changes and gross or microscopic lesions in the tissues of high dosage rats and mice. (Industry ad hoc committee and National Toxicology Programme).

8. Chronic Toxicity/Carcinogenicity Studies using sodium cyanurate showed no treatment related mortality, no evidence of dose-related gross or microscopic pathological changes in test and sacrificed animals examined up to 18 months. (Industry ad hoc Committee, Cascieri et al Toxicologist 5: 58 1985).

7. ECOTOXICOLIGICAL STUDIES

7.1 Possible routes of entry to the environment according to the foreseen manner of application or use.

General draining system.

7.2 Information on the ecotoxicology of the active ingredient

Cyanuric acid and derivatives which revert readily to cyanuric acid (e.g. chlorinated isocyanurates) biodegrade readily under a wide variety of natural conditions, and particularly well in systems of either low or zero dissolved-oxygen level, such as anaerobic activated sludge and sewage, soils, muds and muddy streams and river waters, as well as ordinary aerated activated sludge systems with typically low (1 to 3 ppm) dissolved-oxygen levels. Degradation also proceeds in 3.5% sodium chloride solution. Consequently, there are degradation pathways widely available for breaking down cyanuric acid discharged in domestic effluents. The overal degradation reaction is merely a hydrolysis; CO_2 and ammonia are the initial hydrolytic breakdown products. Since no net oxidation occurs during this breakdown, biodegradation of cyanuric acid exerts no primary biological oxygen demand. However, eventual nitrification of the ammonia released will exert its usual biological oxygen demand. Biodegradation of cyanuric acid also takes place in systems of considerable salinity (36)

Studies carried out by the Department of Agricultural Microbiology in Poland (37) have shown that cyanuric acid was not toxic for soil microorganisms examined and was even observed to stimulate the growth of Azotobacter in chernozem. Some isolated fungi were capable of cleaving the ring of cyanuric acid. With the use of ^{15}N-labeled cyanuric acid it was found that the nitrogen taken from this compound by Aspergillus minutus and Pseudogymnoascus sp. was incorporated into their proteins. About 70-90% of ^{15}N derived from cyanuric acid was detected in the biomass of the examined fungi. The ability of soil microorganisms to cleave the triazine ring is of importance in the detoxication of soils treated with triazine herbicides.

7.3 Available information concerning the ecotoxicity of the active ingredients

Refer to 7.2

8. MEASURES WHICH MUST BE TAKEN FOR THE PROTECTION OF MAN, ANIMALS AND ENVIRONMENT

8.1 Recommended methods and precautions regarding the handling, use, storage, transportation and in case of fire:

HANDLING AND STORAGE

Recommended Storage Conditions:

- Store away from all incompatibles and combustibles.
- Store in a cool, dry, well ventilated place.
- Moisture sensitive.
- Avoid high humidity levels.
- Do not allow water to get into container.
- Keep away from fire, heat, flame and direct sunlight.
- Keep container tightly closed.
- Keep out of reach of children.
- Never store damp or contaminated material.

Recommended Handling Precautions:

- Avoid breathing any dust.
- Do not eat, drink or smoke when handling this material
- Use protective equipment:

Respiratory Protection:	Where any dust in the breathing zone cannot be controlled with ventilation, wear an officially approved respirator (NIOSH/MSHA or equivalent agency) for protection against airborne dust.
Ventilation:	Use local exhaust ventilation where appropriate.
Eye Protection:	If airborne dust concentrations are high, wear appropriate protective goggles.Wash eyes with clean water where there is potential eye contact.
Skin Protection:	When handling large bulk quantities wear protective gloves. Wash immediately if skin is contaminated. Remove and wash contaminated clothing and clean up equipment before re-use. Wash thoroughly with soap and water after handling.

Conditions to Avoid:

- Do not store on or near heat sources or naked flame.
- Avoid moisture.
- NaDCC decomposes at temperatures above 240°C liberating toxic gases.

Materials to Avoid:

- Contact with water liberates chlorine and with nitrogen compounds may cause explosion.
- Avoid organic materials, oils, grease, sawdust, reducing agents, nitrogen containing compounds, sodium hypochlorite, calcum hypochlorite, other oxidizers, acids, alkalis, cationic and certain non-ionic surfactants.

TRANSPORTATION INFORMATION

- CHEMGENE NaDCC is classified as non-hazardous for transport under The Carriage of Dangerous Goods (Amendment) Regulations 1999.
- The product must be kept strictly dry and away from fire, heat, flame and direct sunlight.

FIRE-FIGHTING MEASURES

Special Fire or Explosion Hazards:

- Product is not flammable itself, but contact with combustible material may cause fire.
- Product combustible if dehydrated by drying.
- Decomposes above 250°C with release of chlorine and other toxic fumes.
- A thermal decomposition can be extinguished by flooding with copious amounts of water or by isolating the decomposing material in open air and allowing it to be consumed.
- Use self contained breathing apparatus and goggles.
- Do not approach from leeward.

Suitable Extinguishing Media:

- Pressurised water or dry powder.
- Do not use dry fire extinguishers containing ammonium compounds.

Other Recommendations:

- Remove the product if it is safe to do so, before using water for fire fighting, in order to minimise hazards from release of toxic fumes.
- It will often be safer to let the fire but itself out.
- Where it is decided to fight the fire with water, large quantities **must** be used.
- If insufficient water is used there may be an explosion hazard associated with hot damp material.

8.2 Special action that must be taken in case of accident:

FIRST AID MEASURES

Eye Contact:

- Immediately flush with plenty of clean water for at least 15 minutes. If irritation persists, seek medical attention.

Skin Contact:

- Wash thoroughly with water.
- Remove contaminated clothing.
- Wash any contaminated clothing well before re-use.

Ingestion:

- Immediately rinse mouth, then drink plenty of water or milk.
- Do not induce vomiting.
- Seek medical attention. See Guidelines Reference (23).

Inhalation:

- Move to fresh air.
- If irritation persists, seek medical attention.

ACCIDENTAL RELEASE MEASURE

- Any spillage's should be cleaned up as soon as possible to prevent contamination with foreign materials with which it may react.
- Handle spillage carefully, do no return spilled material to original container.

If tablets are dry and uncontaminated:

- Collect up into heavy-duty plastic bag; where possible and suitable, use material as originally intended.
- Wash away any residues with copious amounts of water.

If tablets are contaminated:

- They should be transferred to waste ground, spread thinly and covered with a thin layer of earth; a smell of chlorine will be noted until the material has degraded.
- Keep people, vehicles and animals away from the disposal area.

If tablets become damp:

- They will effervesce, evolving carbon dioxide and may decompose to give off chlorine fumes; transfer spillage to unsealed plastic bags avoiding any large masses of material within the bags and remove to waste ground for immediate treatment/disposal as above; avoid breathing fumes.
- Wash away residues with copious amounts of water.

If spillage of tablets is large (more than 100Kg):

- Place into bins lined with polythene bags and eliminate in accordance with locally valid disposal regulations.

8.3 Procedure for cleaning equipment:

- Rinse thoroughly with cold water.
- If necessary, a neutral detergent can be used after rinsing with water.
- Follow usual cleaning procedures.

8.4 Identification of the relevant inflammable products in case of fire:

- NaDCC is not flammable itself, however, a thermal decomposition will occur at above 240°C.

8.5 Disposal considerations:

- Disposal should be done in accordance with all official local regulations.
- If material is dry, incineration is recommended.

8.6 Observations regarding undesirable effects or reactions:

- Keep the product away from moisture, NaDCC readily decomposes to chlorine, hypochlorous acid and cyanuric acid.
- Chlorine and hypochlorous acid are known to be toxic to wildlife, especially fish.
- Mixing with sodium or calcium hypochlorite will cause explosive generation of nitrogen trichloride.

8.6 Definition of the measures of controlling harmful ingredients or poisons contained in the product with the aim of preventing activity against non-target organisms:

- The intended use of the product does not require any special measures.

9. CLASSIFICATION, PACKAGING AND LABELLING

Label for supply: HARMFUL

Risk Phrases:

R22	Harmful if swallowed.
R31	Contact with acids liberates toxic gas
R36/37	Irritating to eyes and respiratory system
R52/53	Very toxic to aquatic organisms, may cause long adverse effects in the aquatic environment

Safety Phrases:

S8	Keep container dry
S26	In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S41	In case of fire and/or explosion do not breathe fumes

Regulatory References: The Chemical (Hazard Information & Packaging) Regulations 2002 (as amended).

Packaging:

1.08g & 3.25g	Plastic. Dines 850ml jars
9.7g	Plastic. Dines 1250ml jars
500 g granules	Pot white 500g shaker

10. SUMMARY

CHEMGENE NaDCC Effervescent Chlorine Tablets

These small, white tablets are based on dry chlorine donor, sodium dichloroisocyanurate (NaDCC) which is blended with effervescent components before being compressed into tablet form. The result is a fast-dissolving, highly convenient, safer and more accurate alternative to liquid bleach.

Chlorine is regarded by many, including the Health Service and the Government, as the most effective disinfectant in the fight against disease. That is why it is recommended by the world's major authorities for use against HIV (AIDS) and Hepatitis B viruses and why almost all of the world's piped water supplies are treated with chlorine.

Disinfecting solutions prepared from HydraChem Effervescent Chlorine Tablets containing NaDCC are fast acting and have a complete spectrum of biocidal activity. Bacteria, bacterial spores, algae, fungi, protozoa and viruses are all sensitive to their effects.

Solutions remaining after the use of CHEMGENE NaDCC contain cyanuric acid or its salts. Within the environment, cyanurate is readily degraded by micro-organisms.

The problem of corrosion associated with liquid bleach has often resulted in the use of more expensive and less effective alternatives. It has been demonstrated that chlorine solutions produced using NaDCC tablets are in general significantly less corrosive.

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