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FEEDWATER LTD	PROCEDURE REF:	CC014
CHEMICAL CLEANING METHODS	ISSUE NO:	005
DISINFECTION WITH CHLORINE DIOXIDE USING ACTIV-OX	DATE:	20/10/2003
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14.1 THEORY

Chlorine Dioxide is a more potent oxidising disinfectant than Chlorine and offers the additional benefits of (i) not being pH sensitive and (ii) being able to penetrate and disperse biofilms.

ACTIV-OX is a Chlorine Dioxide donor which requires activating to 'unlock' the potency of Chlorine Dioxide. Activation is achieved by the addition of ACTIV-8.

ACTIV-OX is available in 2 strengths ACTIV-OX-20 for large systems and ACTIV-OX-10 for small tanks and surface disinfection techniques.

14.2 SAFETY WARNING

Chlorine Dioxide like Chlorine is a toxic gas so activation should only be carried out in a well-ventilated area. Activation should only be carried out in diluted solutions. NEVER MIX NEAT ACTIV-OX AND ACTIV-8.

Review the generic risk assessment for the procedure and ensure that all the necessary control measures are in place and the correct PPE is worn when handling chemicals. Ensure that the customer has received a signed copy, and is in agreement with the content thereof, before commencing work.

If a 'Permit to Work' system is in operation, obtain necessary permit.

14.3 MONITORING

Whilst ACTIV-OX actually yields Chlorine Dioxide for disinfection purposes it is easily measured using acidified potassium iodide and a high range Chlorine Comparator disc and the reserve expressed as mg/L Cl2.

For disinfection by soaking an initial reserve should be established of at least 50mg/L as Cl2 to both domestic storage tanks and cooling towers and the residual monitored periodically to ensure an active reserve of at least 10 ppm as Cl2 is maintained at the end of the required time. (See Measurement, Section 14.6)

14.4 DISINFECTION TECHNIQUES

There are two techniques which can be employed for disinfections:

(A) Soaking using approximately 25mg/L of Chlorine Dioxide
(B) Surface disinfection using approximately 50mg/L of Chlorine Dioxide

14.4(A) Disinfection by Soaking

(i) Work out the total system volume in m3 and chemical requirements as follows:

EITHER (a)	ACTIV-OX-20	=	1 litre/m3
	+ ACTIV-8	=	1 litre/m3
OR (b)	ACTIV-OX-10	=	2 litre/m3
	+ ACTIV-8	=	2 litre/m3

If only a small quantity is needed then this can be made up in a 25 litre drum but for larger quantities of activated solution the specially designed venturi injection system should be used.

(a) Making up small quantities of ClO2 in a 25L drum

- Take a clean empty 25 litre drum and make up an activated stock solution by taking either 1 part ACTIV- OX-20 or 2 parts ACTIV-OX-10 and dilute with 18 parts clean water. Put the top on the drum and agitate to mix.
  N.B. For safety and simplicity it is recommended that this dilution of ACTIV-OX be made off site and the prediluted solution be transported to site in 25L drums.

- Add the ACTIV-8, put the top on the drum and agitate to mix.

- Add the activated solution to the tank by pouring or pumping taking care not to breath any fumes and ensure as far as possible minimum splashing and agitation of the activated mixture as this tends to release ClO2 from solution.
  N.B. In order to ensure good mixing you should start with a half filled tank and add the activated mixture and then fill the tank to the top.

(b) Making up larger quantities of ClO2 using venturi injector system

- Connect the suction tubes to the venturi injector system and lower it into the tank ensuring the outlet hose is secured below the surface of the water.
- Turn the power on and test the operation of the venturi injection system with water ensuring the suction on both injectors is approximately the same - if not check for air leaks in the suction tubing.
- Use the system to draw the required quantity of ACTIV-OX and ACTIV-8 into the system and then continue to run the system just drawing water until the sump pump has adequately mixed the contents of the tank.

  N.B. It is recommended that the system is not allowed to suck in too much air since this may encourage the release of ClO2 to the atmosphere.

(ii) Once the activated solution is in the system and adequately mixed, check that a reserve of at least 50mg/L as Cl2 is given. Add more activated solution if necessary.

(iii) Retest the reserve every 15 minutes and ensure that a residual of at least 10mg/L as Cl2 is given after the required contact period of one hour.

(iv) After the one hour soak period the system can be drained and flushed out and provided the system volume is less than 2m3 and the residual less than 20mg/L as Cl2 it can be discharged to sewer without deactivation. Where the residual or volume is greater it should be deactivated using the method in Section 14.5

14.4(B) Surface Disinfection

Here the tank surfaces are disinfected by either brushing, sponging or spraying with an activated solution such that they remain wetted for at least 10 minutes.

Warning Whilst highly soluble Chlorine Dioxide is easily lost from solution and this technique, particularly when spraying, must only be used with great care in a well ventilated environment by personnel equipped with appropriate respiratory protective equipment or breathing apparatus and after an adequate risk assessment has been carried out.
Any spray equipment used should be set to its coarsest setting so as to produce large droplets and not a fine mist in order to minimise the losses of ClO2 to the atmosphere.

(**i)** Establish the volume of surface disinfection solution which will be used and make up an activated 'stock' solution in a clean drum as follows:

1 part ACTIV-OX-10
18 parts clean water put the lid on the drum and agitate then add 1 part ACTIV-8 and re-seal and agitate the drum

One litre of activated 'stock' solution (50ml ACTIV-OX 10, 900ml water, 50ml ACTIV-8) should be made per 10 litres of surface disinfection solution required and carefully added to the final volume.

Example Quantity of surface disinfection solution being used = 50L
Quantity of activated 'stock' solution required = $\frac{50}{10}$ = 5L

5L of activated stock solution will comprise:

a)	5 x 50ml	=	250ml ACTIV-OX-10
b)	5 x 900ml	=	4.5L clean water
c)	5 x 50ml	=	250ml ACTIV-8

(ii) Brush, sponge or spray the surface to be disinfected with surface disinfection solution so that the surface remains wetted for at least 10 minutes.

(iii) After the required 10 minute contact time has been maintained rinse the surface with clean potable water.

(iv) Small quantities (100L or less) of surface disinfection solution can be discharged to sewer without deactivation but for greater quantities DECHLOR should be added at the rate of 150ml per 100 litres of surface disinfection solution to be washed to drain.

14.5 DEACTIVATION

If the water volume is less than 2 m3 and the residual Chlorine Dioxide content is less than 20 mg/L as Cl2 then it is probably acceptable to discharge the water to sewer without further deactivation.

However, for larger volumes/higher residuals then this should be deactivated using DECHLOR (Sodium Thiosulphate Soln.)

To calculate the quantity of DECHLOR required measure the Chlorine Dioxide expressed as Cl2 and add 11 ml of DECHLOR per mg/L per m3.

Example	System Volume	=	8 m3
	Chlorine Dioxide level	=	30 mg/L (as Cl2)
	Quantity of DECHLOR required:	=	11(ml) x 8(m3) x 30 (mg/L)
		=	2640 ml
		=	2.64 L of DECHLOR

N.B. The effluent from a cleaning operation whether neutralised or not should not be discharged to surface water without the necessary prior consents.

14.6 MEASUREMENT

Once activated ACTIV-OX will produce a yellow/green solution and the depth of colour is a crude indication of the level of active Chlorine Dioxide in solution.

The levels of Chlorine Dioxide used for disinfections can most easily be measured using a modified high range chlorine test as follows:

i) Fill a comparator tube to the 10ml mark with sample.
ii) Add one Acidifying GP tablet, crush and mix to dissolve (this step is important).
iii) Add either one 0.3g Potassium Iodide tablet or one Chlorine HR tablet, crush and mix to dissolve.
iv) Read the "Chlorine" level using the appropriate high range Chlorine comparator disc or diskette.
For most purposes it will be sufficient to measure and express the Chlorine Dioxide residual as mg/L Cl2, if, however, it is necessary to express it as mg/L ClO2 this can be done by multiplying the Chlorine reading by 0.38 e.g. 10mg/L as Cl2 = 3.8 mg/L as ClO2.

14.7 COMPLETING JOB SHEETS/RECORD KEEPING

- Record any significant points about system prior to work in "Engineer's comments…" section e.g. if something isn't working
- Confirm effluent will run to foul drain and delete "Yes/No" as appropriate
- Record details of disinfection
  - sample point
  - time and date of sampling
  - chlorine level
- Complete "Engineer's Report" section
  - brief description of work done
- Record any update / correction information for the contract system
- Complete the '' Tank Inspection'' form, (if appropriate), by ticking the appropriate boxes. The 'Satisfactory' box should only be ticked if there are no non-conformities present. The ''Urgent remedial works required'' box should only be ticked if any of the following non-conformities are present:
  - high risk of faecal contamination by pigeons or other birds/rodents
  - risk of water damage due to leaking tank

  Other non-conformities will indicate that ''Remedial works required''.
- Complete dates / times and mileage information
- Write legibly!
- Sign report
- Discuss with client and verbally report "matters of evident concern"
- Immediately inform your line manager if ''Urgent remedial works required''
- Forward completed reports to office promptly.

14.8 PROTECTING THE ENVIRONMENT

- Locate and use the foul drain (sewer)
- Take care to avoid chemical spillage's
- Find out site contact for emergencies
- Always neutralise chlorine / chlorine dioxide residuals with Dechlor before draining
- Never allow effluent to enter surface water without express permission
- Remove empty drums and any rubbish generated by the works from site and ensure that these are disposed of via a licensed waste disposal contractor. It maybe possible to arrange for re-cycling of empty drums.