



East Central Railway

Office of the
General Manager (Engg)/Hajipur

PCE's CIRCULAR No- 29/2008/WORKS

Sub- Chlorination of water

1.0 Generally following three methods are adopted for chlorination of water using different chlorine producing agents.

- (a) Bleaching powder solution is added to the water, releasing the chlorine available in it to ensure disinfection of water. This method is suitable only for smaller capacity installations.
- (b) Using Sodium Hypo chlorite.
- (c) Chlorine is obtained directly from the cylinders filled with pure chlorine in gaseous or liquid form. This method is generally adopted for larger size water supply plants.

The first method of chlorine application has the merits of simplicity, non requirement of electrical energy and relative safety in operation and handling. However, the demerits include instability of bleaching powder, its hygroscopic nature and relatively low % of available chlorine (25-33%).

The second method requires the deployment of either salt based electro chlorinators or Microprocessor based chlorinator using commercial sodium hypochlorite. However, no IS specifications are presently available for these equipments.

The third method of chlorine application is presently the common practice for medium to large public water supplies. However; it requires elaborate safety practices and use of chlorinators or chlorine evaporators and auxiliary equipments.

2.0. Chlorination using bleaching powder

Bleaching powder or calcium hypochlorite is a chlorinated lime, which contains about 25 to 34 % of available chlorine by weight. When it is mixed with water; the calcium hypochlorite decomposes into calcium chloride and chlorine.

Bleaching powder is characterized by available chlorine it liberates by complete reaction with water. Commercial brands of bleaching powder have available chlorine of 20% to 30% by weight. Grade-I bleaching powder as per IS: 1065 should be used for water treatment which should have a minimum of 30% of chlorine.

2.1 PREPERATION OF BLEACHING POWDER SOLUTION-

- (i) The concentrated solution of bleaching powder is prepared in one or two tanks of capacity suitable for 24 hours requirement.
- (ii) The tank inside should be of glazed tiles or stone ware and should be covered.
- (iii) The powder is first put on a perforated slab placed longitudinally inside the tank at a higher level, with respect to bed level of tank.
- (iv) Water is sprinkled on the powder through a perforated pipe above this perforated slab & the solution of water and bleaching powder is thus injected into tank.
- (v) The solution is rotated for thorough mixing of powder with water by a hand driven/motor operated stirrer.
- (vi) The precipitates of calcium hydroxide settles at the bottom of the tank. The supernatant water, which contains OCl^- , Cl^- is used for disinfectant.

2.2 PRECAUTIONS-

- (i) The bleaching powder is hygroscopic in nature. It loses its chlorine strength rapidly due to storage and hence should not be stored for more than three months.
- (ii) The operating personnel should use hand gloves, aprons and other protective apparel, while handling and mixing.

3.0 Chlorination using Sodium Hypo chlorite

There are two methods for using hypochlorite. It can be purchased in bulk in the form of commercial hypo chlorite conforming to IS 11573: 1992 or can be generated on site by way of electrolyzing a solution of brine or common salt and the chlorine so produced is used for disinfection.

3.1 On site generation of Sodium Hypo chlorite-

On site, generation of sodium hypo chlorite is being done by installing salt based electro chlorinator. In the electro chlorination process food grade salt/Salt Grade-2 as per IS 797:1982 is used. This equipment produces hypo chlorite solution through electrolysis of sodium chloride (brine), where chlorine is discharged at anodes and a small quantity of hydrogen gas is liberated at cathode. Electro chlorination system does not evolve chlorine as a gas, but is available in the dissolved form as sodium hypochlorite solution and hydrogen gas is vented to the atmosphere.

The sodium hypo chlorite so produced is injected into filtered water with the help of dosing pump. The hypochlorite solution when added to water has the same biological and oxidizing power, which is equivalent to chlorine gas and provides the same degree of disinfectant.

The performance of electrochlorinator based on common salt in other Railway is found satisfactorily as it is evident from ME's D.O letter No-D.O.No.2004/LMB/9/1 dt 13.04.04(Copy enclosed). This system of chlorination is also recommended by Manual on operation & Maintenance of water supply system published by Central Public Health & Environmental Engineering Organization-Ministry of Urban Development .The extract of this manual is also attached as Annexure-A(In ten pages) for ready reference.

After installation & commissioning of the equipment, the system will be run by departmental manpower and maintenance of the machine beyond the warranty period, Annual maintenance contract should be fixed. It is to be ensured that details of the spare parts of the equipment must be described in the tender schedule so as to minimize the AMC cost.

3.2 Chlorination by using commercial sodium hypochlorite-

Commercial Sodium Hypochlorite conforming to IS: 11673-1992 is available in two grades. Grade-I.chemical is used for treating drinking water and Grade-2 chemical is used for industrial application.

Microprocessor based chlorinator of different makes are available in the market. Operation of the chlorinator will be by departmental manpower only. In order to run such type of chlorinators, It is required to purchase commercial sodium hypochlorite of Grade-1 conforming to IS: 11673-1992 and for maintenance of the machine beyond the warranty period, AMC will have to be fixed. It is to be ensured that details of the spare parts of the equipment must be described in the tender schedule so as to minimize the AMC cost.

4.0. Conventional Chlorination i.e. Using Chlorine for disinfection-

The conventional chlorination i.e. adding chlorine for disinfection of water treatment consists of three essential parts:

- (a) Chlorine Supply System**
- (b) Metering System**
- (c) Diffuser System**

In addition to above, there are ancillary equipment, safety equipment, metering & control instrumentation and chlorine residual analyzers.

- (a) Chlorine Supply system-** Chlorine gas are being supplied in cylinders or ton containers. Chlorine cylinder delivers gas when in an up right position and liquid when in an inverted position. Ton cylinders in a horizontal position deliver gas from upper valves and liquid from lower valve. To withdraw gas from a cylinder or ton container, the liquid chlorine must be vaporized.

Specifications and manufacturing of chlorine, cylinders/containers, their transportation, handling, filling, possession and safety shall be governed as per Gas Cylinder Rules: 1931 of Central Government.

(b) Metering System- Chlorinator

A chlorinator is a device for feeding chlorine to a water supply system. It also serves as gas metering device. Chlorinators are classified into two categories.

- **Pressure type**
- **Vacuum type**

The **pressure type** may be further classified into two groups on the basis of gas or solution feed.

(i) Dry Feed Type

Presently this is not used for water treatment due to safety reasons.

(ii) Aqueous Solution Feed Type

In this method measured feed of chlorine gas is dissolved in a minor flow of water which is then added to the main bulk of water. For this purpose three distinct types of solutionisers are available. In these systems, minimum 1500 liters of water is required per kg of chlorine for making chlorine solution. If the pressure is increased the quantity required for making the solution is decreased. The temperature of the water used for preparing the solution must be more than 10°C. If the temperature of the water is less it must be heated by safe methods before using for solution. However this method is also not in use at present.

• Vacuum Type Chlorinator

In this type of chlorinator, chlorine is handled below the atmospheric pressure. The vacuum system has several advantages:

- (i) It is the easiest method of dissolving chlorine in water.
- (ii) Chlorine is easily handled when in solution.
- (iii) This is the most accurate way of metering chlorine gas since a constant density is maintained under vacuum and it is not affected by ambient temperature changes.
- (iv) Operation under vacuum is safer than operating under pressure.
- (v) A metering system can be easily designed to stop automatically if the vacuum should fail.

4.1. Comparison of chlorinators:- comparison of various types of chlorinators are as under:-

S. N.	Description	Pressure Type Chlorinator (At present not in use)			Vacuum Type Chlorinator	
		Dry feed	Aqueous solution feed		With Differential vacuum regulator	Sonic flow type
			Gravity feed	Injector Solutioniser		
1.	Rate of feed (max)	230 kg/d	230 kg/d	230 kg/d	4800 kg/d	240 kg/d
2.	Water requirement per kg of chlorine (min.)	Nil	1500 lit.	Less than 1500 lit. but more than 300 lit.	300 lit.	300 lit
3.	Accuracy	Low	Low	Low	High	High
4.	Flow meter	Manometer	Manometer	Manometer	Rotameter	Rotameter
5.	Pressure at point of application	0.7kg/cm ² (max)	0.7kg/cm ² (max)	More than 0.7kg/cm ²	More than 0.7kg/cm ²	More than 0.7kg/cm ²
6.	Energy requirement	Low	Low	Moderate	Moderate	High
7.	Maintenance	Extensive	Extensive	Extensive	Moderate	less
8.	Status	Not in production	Not in production	Not in production	In production	In production

4.2 Safety aspects of Chlorine

- (i) Chlorine is potentially dangerous. It is, therefore, important that person engaged in a chlorine plant or in any activity involving handling of chlorine should understand the hazards of chlorine and should know preventive measures needed.
- (ii) Cylinders are fabricated as per IS: 7681.
- (iii) Bigger containers are commonly known as 'Toners' Indian toners are generally fabricated conforming to the British standards (B.S:1500).
- (iv) Both chlorine cylinder as well as toners must be fitted with standard valves conforming to IS: 3224.
- (v) Chlorine is stored in special grade steel containers. As per IS: 4379-1967, the colour of Chlorine container should be 'golden yellow'.

4.3. Standards related to chlorinators:- Following BS/IS codes are related to chlorinators-

1.	BS:1500	For tonners.
2.	IS: 7681	Specification for welded low carbon steel gas cylinders for chlorine gas
3.	IS: 3224	Specification for valve fittings for compressed gas cylinders.
4.	IS: 4263	Code of practice for chlorine.
5.	IS: 10553	Parts I & II: Requirements for chlorination equipment.
6.	IS: 5844	Recommendations for hydrostatic stretch testing of compressed gas cylinders.
7.	IS:4379	Identification of contents of industrial gas cylinders.
8.	IS: 646	Specification for liquid chlorine.
9.	IS: 8198 Part 6	Code of practice for steel cylinders for liquefied chlorine gas.
10.	IS: 5845	Code of practice for visual inspection of low pressure welded steel gas cylinders in use.
11.	IS: 8868	Periodical inspection interval of gas cylinders in use.
12.	IS: 9200	Methods of disposal of unserviceable compressed gas cylinders.
13.	IS: 5903	Recommendation for safety devices for gas cylinders.
14.	IS: 3710	Filling ratios for low pressure liquifiable gases contained in cylinders.

4.4. Statutory Regulations in connection with use of chlorine

Applicable Acts and Rules are:

1. The Gas Cylinder Rules 1981.
2. The Factories Act 1948
3. The Manufacture, Storage and Import of Hazardous- Chemicals Rules, 1989.
4. Public Liability Insurance Act & Rules, 1991.
5. The National Environment Tribunal Act 1995

6. Chemical Accident Rules 1996
7. National Environment Appellate Authority Act & Rules 1997.

5.0 Residual Chlorine

Satisfactory disinfection by any of the above methods should ensure free available residual chlorine to the extent of 0.2 to 0.5 ppm at the consumer point at normal PH value. At higher PH value of 8 or 9 at least 0.4 ppm of residual chlorine is required for complete bacterial kill with 10 minutes contact period. The dosage may be reduced to have 0.2 to 0.3 ppm of residual chlorine.

When there is a fear of epidemic of water born diseases, the supply should be prechlorinated for six hours to maintain free available residual chlorine of 0.4 to 0.5 ppm.

Where the water source is from an open river, canal or pond, it is recommended to have an amount of free residual chlorine to the extent of 0.4 ppm to 0.5 ppm and allow a minimum of contact period of 60 minutes.

The Section Engineer (Works) should frequently check the concentration of residual chlorine at the consumer point by orthotolodine test. In this test 100ml of chlorinated water sample is collected in the test tube. 1ml of orthotolodine solution is added to it. The colour formed is noted, value of the residual chlorine is directly determined by comparing the colour so obtained with the standard chart of colours of non-chlorine residuals. It is to be ensured by the divisional engineers that sufficient number of equipment are made available with all the field units.

6.0. Divisions may adopt any of the above systems of chlorination of water as mentioned vide item 2.0, 3.0 & 4.0 above. However, before finalizing the scheme of chlorination by any of these methods demand of water supply, initial installation cost and running cost as well as total cost of chlorination must be worked out and accordingly best suited scheme is to be adopted.

Anal
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(V. KUMAR)
Chief Engineer/Works

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1. CAO/Con/N, CAO/Con/S/MHX for information PI.
2. DRM/DNR, DHN, MGS, SPJ & SEE for information PI.
3. Sr.DEN/ (Co-ord)/DNR, DHN, MGS, SPJ & SEE for information and necessary action.
4. All HODs, Dy HODs/Engg Deptt/ECR

V. Kumar
DY. CE/WORKS