

KLORMAN[®]

STANDARD UNIT



USERS GUIDE

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1. Introduction

Dear Customer...

You have become the owner of the Klorman™ Hypochlor® dispenser. The Klorman™ is a compact, easy to install, easy to use chlorinator that converts feed-water into a continuous stream of active chlorine sanitizer. Klorman™ is ideal for any application where viruses, bacteria, fungal spores and protozoa need to be controlled. In most processes, only 10% of water used is usually responsible for 90% of all sanitation problems, and experience has shown that to chlorinate all input water at a single point in a facility is simply not the answer, since sanitation requirements vary for different applications.

As a **POINT-OF-USE** chlorinator, Klorman™ can be installed at critical points in the production chain to supply effective sanitation at key points in the process. The unit dispenses **Hypochlor®**, a mild calcium-based chlorine that forms a sanitizing solution which is non-corrosive, pH stable and environmentally safe.

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Distributed by:

2. Approvals And MSDS Information

2.1 Existing Standards and Federal Approvals

1. Regulatory Position: The Klorman™ is EPA Registered as calcium hypochlorite based water treatment chemical. Registration No: 57425-3.
2. Calcium hypochlorite, as dispensed by the Klorman™, is EPA registered for use without tolerance to chemical residue on all agricultural commodities for pre- and post harvest purposes. (40 CFR 180. 1054). (Note that similar approval is not extended to liquid sodium hypochlorite bleach). It is approved by the FDA Food Additives Branch for food contact, as well as by the USDA-FSIS for egg, meat and poultry sanitizing.
3. Patent numbers and Trade Marks: US Patents. 4,842,729/4,192,763. Other Patents Pending.
 - Australia 62430/80. Chile 255-40. Japan 209369/86. Pending.
 - South Africa. 86/6822. EPO Pending. Other Patents Pending.
 - Trade Mark, US Reg. TM. 1,532,893.

2.2 PRECAUTIONARY

WARNING OXIDIZING AGENT
KEEP OUT OF REACH OF CHILDREN
READ PRECAUTIONARY STATEMENTS
BEFORE OPENING
CALCIUM HYPOCHLORITE DRY

UN No. 1748 STATEMENT

AGENT
5.1

2.3 Standard EPA Precautionary Statements

First Aid (Practical Treatment)

- If on skin: Brush off excess chemical and flush skin with cold water for at least 15 minutes. If irritation persists, get medical attention.
- If inhaled: Remove person to fresh air. Get immediate medical attention.
- If swallowed: Drink large quantities of water. Do not induce vomiting. Call a physician.
- If in eyes: Flush eyes with water for at least 15 minutes. call a physician immediately.

HAZARDS TO HUMANS AND DOMESTIC ANIMALS: DANGER.

Highly corrosive. Causes skin and eye damage. May be fatal if swallowed. Do not get in eyes, or skin or on clothing. Do not handle with bare hands. wear goggles or face shield and use rubber gloves and only thoroughly clean dry utensils when handling. Irritating to nose and throat. Avoid breathing dust and fumes. Remove and wash contaminated clothing before reuse.

CHEMICAL HAZARDS: DANGER.

Strong oxidizing agent. Mix only into water. Contamination may start a chemical reaction with generation of heat, liberation of hazardous gases, and possible fire and explosion. Avoid any contact with flame or burning material, such as lighted cigarette. Do not contaminate with moisture, garbage, dirt, chemicals including other pool chemicals, pool chlorination compounds, household products, cyanuric acid pool stabilizers, soap products, paint products, solvents, acids, vinegar, beverages, oils, pine oil, dirty rags or any other foreign matter.

EMERGENCY HANDLING:

In case of contamination or decomposition, if possible, isolate container in open and well-ventilated area. Flood with large volumes of water. Dispose of contaminated material in an approved landfill area.

Environmental Hazard:

This pesticide is toxic to fish and aquatic organisms. Do not discharge effluent containing this product into lakes, ponds, streams, estuaries, oceans or public waters unless this product is

specifically identified and addressed in and NPDES permit. Do not discharge effluent containing this product to sewer systems without previously notifying the sewage treatment plant authority. For guidance contact your State water Board or Regional Office.

STORAGE AND DISPOSAL

Keep this product dry in a tightly closed container when not in use. Store in a cool, dry, well ventilated area away from heat or open flame. In case of decomposition isolate container (if possible) and flood area with large amounts of water to dissolve all materials before discarding this container. Do not reuse empty container but place in trash collection. Do not contaminate food or feed by storage or disposal or cleaning of equipment.

Active Constituents: 68%/kg available chlorine (Cl) present as calcium hypochlorite.

Slow releasing, water-soluble tablets for chlorination of waterlines.

DO NOT USE FEEDER WITH ANY OTHER CHEMICAL THAN KLORMAN™ HYPOCHLOR® CHLORINE

2.4 Material Safety Data Sheet (MSDS)

[This MSDS complies with 29 CFR 1910.1200 (The Hazard Communication Sheet)]

Section 1	Product Identification
Chemical Name	Calcium Hypochlorite
Trade Name	Hypochlor® Klorman™
Chemical Family	Inorganic - oxidizing agent - Ca (OCl) ₂
Section 2	Hazardous Ingredients
Not Applicable	
Section 3	Physical Data
Appearance & Odor	White solid; Chlorine odor; Tablet form
Boiling Point	N/A
Vapor Pressure	N/A
Evaporation Rate	N/A
Specific Gravity	Approximately 1
Percent Volatile	None
Section 4	Fire and Explosion Information
Flash Point	N/A

Explosive Limit	N/A
Extinguishing Media	Drench with large volume of water
Fire / Explosion Hazards	Contact contamination with any foreign matter
Hazardous Decomposition Products	Chlorine gas
Section 5 Health Hazard Data	
Hypochlor tablets contain no carcinogenic substances	
Effects of Overexposure	
Inhalation:	effect = cough
Ingestion:	effect = nausea
Eyes:	effect = irritation
Skin:	effect = inflammation
Emergency First Aid	
If inhaled, remove person to fresh air and seek immediate medical attention	
If swallowed, feed large amount of milk or water and induce vomiting.	
If in eyes, flush with cold water for at least 15 minutes and get immediate medical attention.	
If on skin, remove loose powder and flood skin with cold water for at least 15 minutes and if irritation persists get medical attention.	
Section 6 Reactivity Data	
Hazardous Polymerization	Cannot occur
Stability	Stable
Conditions to avoid	Any contact with moisture, heat, acid, organic materials and reducing agents
Incompatibility	Acid, combustible materials, reducing agent
Section 7 Spill or Leak Procedures	
Flush with large amount of water. Do not contaminate ponds, streams or lakes	
Disposal Method	Neutralize with reducing agents such as thiosulfate
Section 8 Special Protection Information	

**** Note **** The special protection specified below is only necessary for handling the raw chlorine tablets. Tablets are packed in disposable plastic cartridges. Under normal handling conditions no protection is necessary.

Also, chlorinated water dispensed by the unit does not require special protection unless water is heated above 140° F causing chlorine gas to be emitted as part of water vapour / steam.

Respiratory Protection	Respirator
Protective Gloves	Rubber gloves
Eye Protection	Goggles

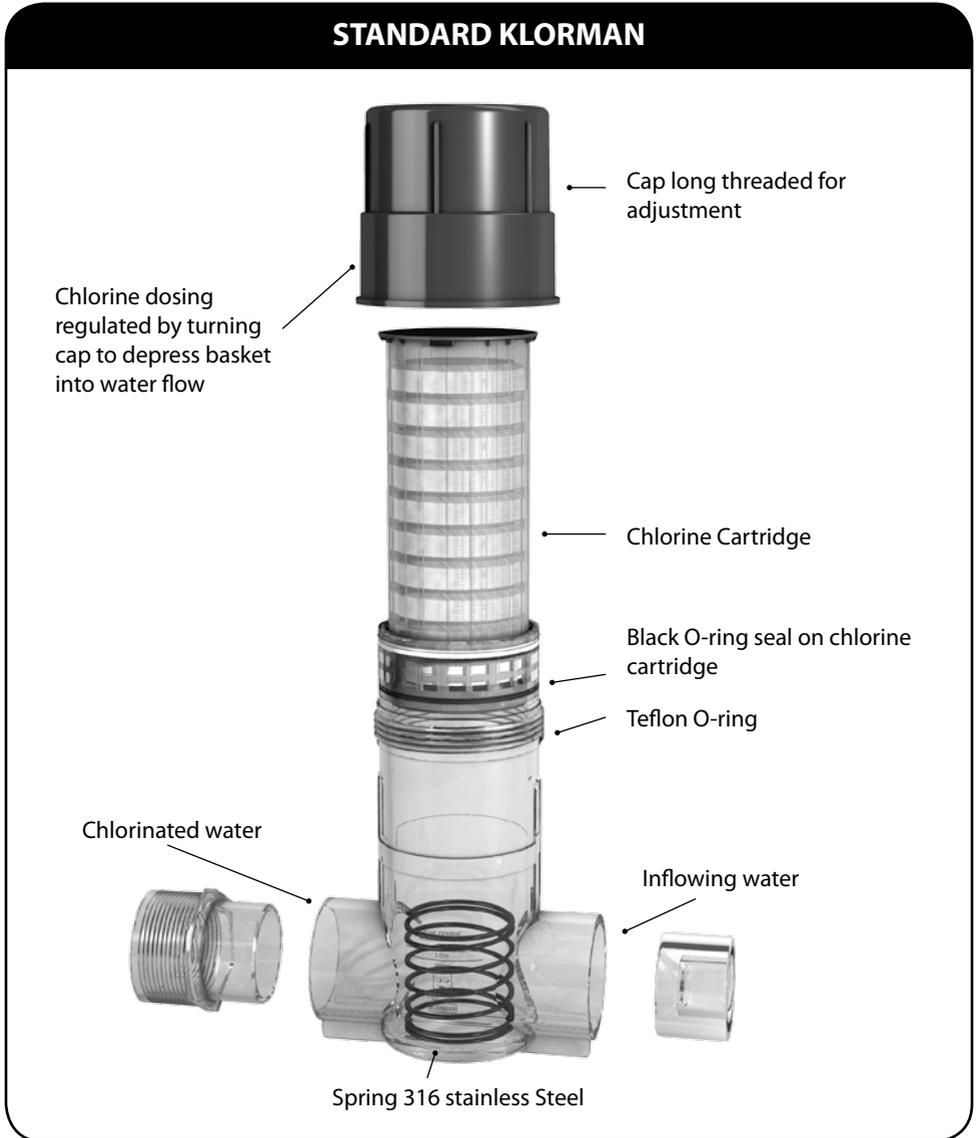
Section 9	Special Precautions
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Handling & Storage.	Keep away from sunlight. Store in a dry, cool, well-ventilated area. Avoid any contact to contamination with moisture, organic matter, reduction materials or other foreign matter.
Other precautions	(IMCO No. 5-1) (U. N. No. 1748)

3. Standard Klorman™ Unit – An Exploded View

The standard Klorman™ Unit has a spring in the chamber which makes it adjustable for purposes of low level chlorination for drinking water or adjustable to high level chlorination for general wash down purposes.

For variable adjustment the chlorine cartridge is equipped with a black plastic seal ring on the base of the cartridge and the Klorman™ has calibration lines on the exterior of the unit body which indicates “LOW” and “HIGH” levels of adjustment.



4. Principles of Operation

The Klorman™ Unit operates through the contact of incoming water with Hypochlor® calcium hypochlorite based tablets. Chlorine concentration achieved in the water line is determined by:→

- Water pressure, i.e. line pressure and/or back pressure.
- Water Flow through the unit i.e. gallons or liters per minute.

The rate of dissolution of the Hypochlor® tablets is therefore solely determined by water pressure and flow. Of these, the water pressure is the most important for optimally utilizing the Klorman™.

- Adjustment of the incoming water pressure could therefore either prevent the water from immersing the tablets in the cartridge, or ensure that the tablets are partially or completely immersed within the cartridge chamber if this is required.
- Each chlorine cartridge is fitted with a black seal-ring that protects the tablets from the feed-water pressure and therefore retards the dissolution of the chlorine tablets. This seal regulates the chlorine level in the water, depending upon water pressure or by adjustment of the cap.

IT IS THEREFORE IMPORTANT TO NOTE THAT, UNLESS THE CARTRIDGE IS EFFECTIVELY CONSUMED WITHIN THE VARIABLES OF EITHER WATER VOLUME OR PRESSURE, CHLORINATION AT THE DESIRED LEVEL CANNOT BE ACHIEVED.

5. Operating Instructions

Once installation has been completed, follow these steps to adjust your Klorman™ unit so that it delivers the required amount of chlorine.

1. Ensure that cartridge and its black seal ring are clean. Place cartridge in chamber and press gently downward. When screwing the cap on, engage threads evenly and press down straight and firmly when turning.
2. Screw cap downward until cartridge seal matches the required settings marked on the exterior of the Klorman body as indicated below.

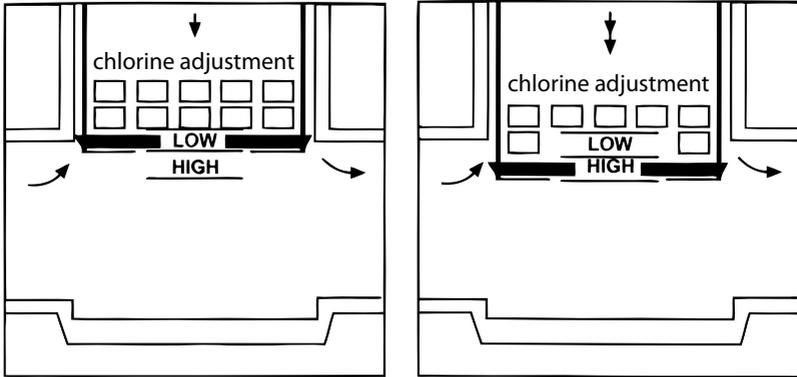
LOW CHLORINE LEVEL ADJUSTMENT

In this setting, the cartridge seal ring is typically located well above water passage. The seal ring is depressed against the sidewall of the unit, and depending upon the water pressure, this should prevent or limit water contact with the tablets. At this adjustment, a single refill cartridge could deliver up to 20 to 50 ppm of chlorine in a standard at pressures of 50 to 60 psi (3.5 - 4.2 Bar).

MEDIUM TO HIGH CHLORINE LEVEL ADJUSTMENT

When the seal ring is adjusted to the middle adjustment line or lower, the tablets will be fully exposed to the water flow. These adjustments are generally suitable to wash down or spray bar applications. Depending on water-pressure or pressure surges, levels in excess of 100 ppm or even 600 ppm can be dispensed.

MEDIUM AND HIGH ADJUSTMENT



NOTE : If cartridges are consumed at a faster rate than expected, this is usually due to pressure surges in the water supply. Intermittent surges of up to 90 psi. (6.4 Bar) are not uncommon in some facilities, and are usually characterized by periodic vibrations or rattling of water lines.

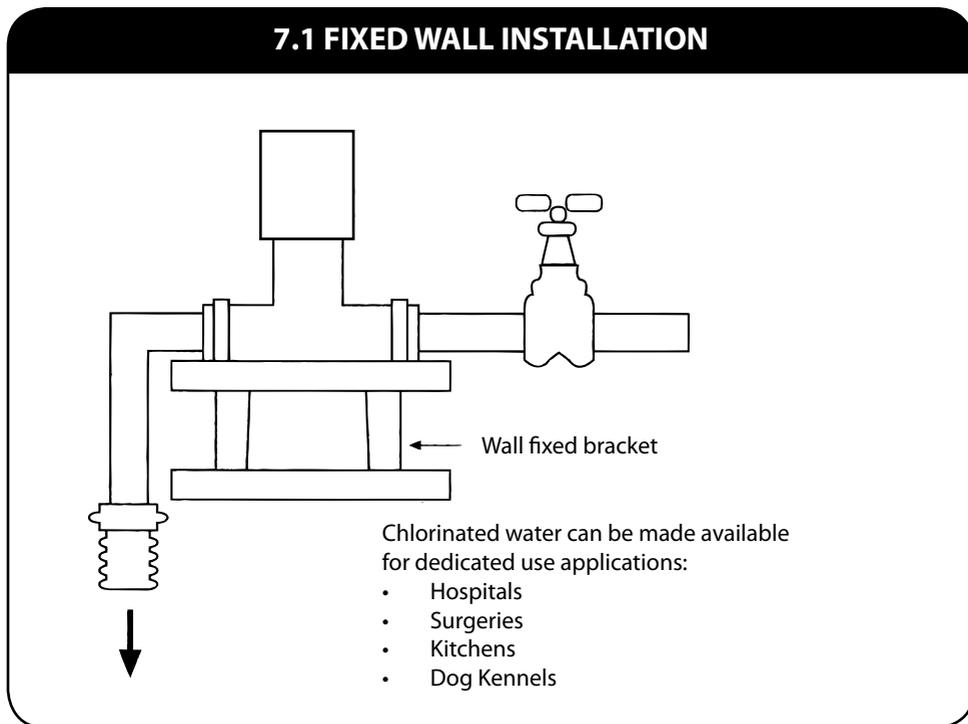
6. Installation Guidelines

1. Enclosed with each unit are two pairs of threaded adapters.
 - If you have purchased your Klorman™ in the USA, these adapters will be 1 set of $\frac{3}{4}$ " and another of $1\frac{1}{4}$ " US standard thread ($1\frac{1}{2}$ " Imperial Standard 50 mm ID).
 - If you have purchased the unit anywhere else, the adapters will be 1 set of $1\frac{1}{2}$ " and another of $\frac{3}{4}$ ".
 - Besides suiting available or intended pipe work, the varying diameter of the fittings will enable the user to create backpressure in the water line to manipulate the chlorine dosage.
 - As a guideline, the smaller the diameter - the higher the backpressure, and therefore the greater the degree of contact between the water and the chlorine.
2. Glue in the required adapter with a bonding agent that is compatible with Acrylic plastic materials. When applying the cement, ensure that it fills the spaces between body parts and adapters to avoid leaking.
3. Threaded adapters (metal or plastic) are of varying tolerance from country to country. To get a proper watertight seal, use plumbing sealant tape.
4. Units must only be mounted vertically. If this is not possible, an angle of 15 degrees must not be exceeded.
5. If flow is too low for water to reach tablets, reduce outlet pipe diameter to create backpressure. Another option is to install an upward elbow in the line after the chlorinator.
6. **IMPORTANT: The KLORMAN™ unit must be installed in such a way as to ensure that it will drain after use. This will prevent tablets from becoming saturated or disintegrating,**

which will lead to excessive chlorine concentrations and accelerated cartridge use.

7. Typical Applications with Diagrams

The Klorman is a versatile unit which can be installed in many ways depending use application.



Fixed Wall Installation 7.1 Installation Within a Waterline

This installation method is applied when the Klorman unit is installed within a waterline where water cannot drain from the chamber when water flow stops. These would typically include installations where Klorman is below spray bars or rain drench installations such as in Figure 7.7.1 page 18. Of these installations, the typical would apply for dairy sanitizing.

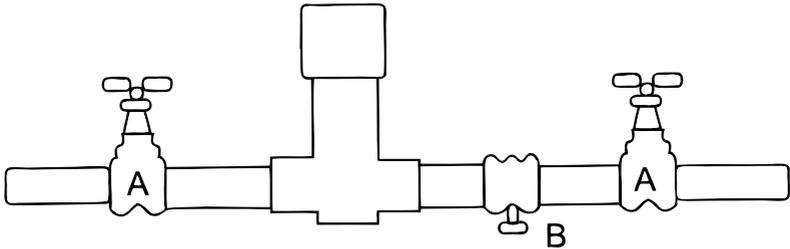
7.1.1. Sanitizing of Dairy Equipment (eg. Alfa Laval and Westphalia type, as well as for rinsing of bulk milk tanks).

The unit should be installed on a dedicated water line leading into the Automatic Dairy Washing (e.g. Alfa Laval Equipment), and can be applied to either pre- or post milking chlorine rinse. Currently, the chemical compounds most widely used for this purpose are acidified iodophor sanitizers. Although they are highly effective sanitizers, these compounds cannot remove the microscopic casein protein film that accumulates on the surface of this equipment, and which cause constant bacterial re-growth within the system. The application of Hypochlor® chlorine

will deliver equivalent or superior sanitizing results than iodine, but has the unique benefit of removing the casein protein film. Installation of the Klorman™ for this purpose will be as illustrated in Figure 7.2 below, where valves are indicated in manual configuration. When used on automatic dairy wash systems, electrical solenoid valves synchronized to the equipment and cycles need to be installed.

Also effective as portable unit below for washing parlor floors in removing slippery and hazardous slime and algae deposits. For control of mastitis and hoof (foot) rot, the typical wall

7.2 INSTALLATION WITHIN WATERLINE



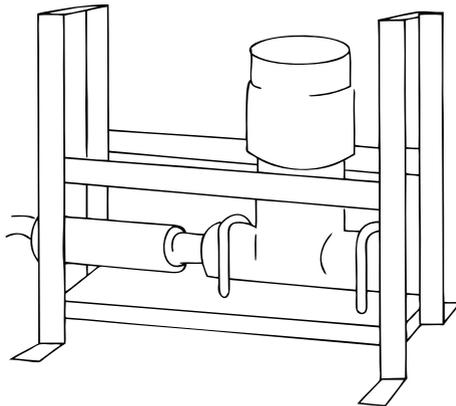
installation as in Figure 7.1 would be applied.

Valves A - used to isolate unit when the Klorman is installed in positions where unit cannot drain naturally.

Valve B - used to drain water from unit when not in use.

7.3 Standard portable unit

7.3 STANDARD PORTABLE UNIT

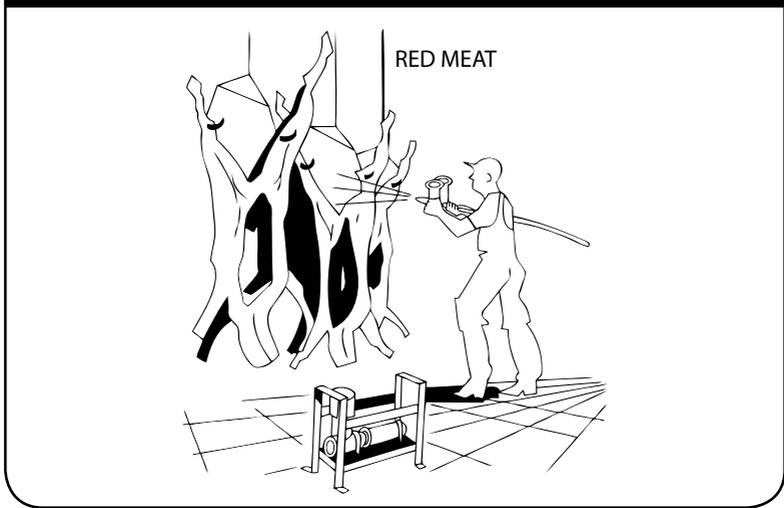


Used for general environmental hygiene, wash down and odour control.
Also widely used for the purpose of mushroom irrigation. When so applied, a filter needs to be installed on unit behind the Klorman to prevent calcium particles from blocking the small openings on watering rose heads.

7.3.1 Hand Held Spray Gun:



7.3.2 KLORMAN UNITS ON DEDICATED WATER LINES



Unit available as spray gun for general environmental hygiene, including for instance the washing of carcasses.

7.4 Installation diagrams for open and closed wells, tanks or dams.

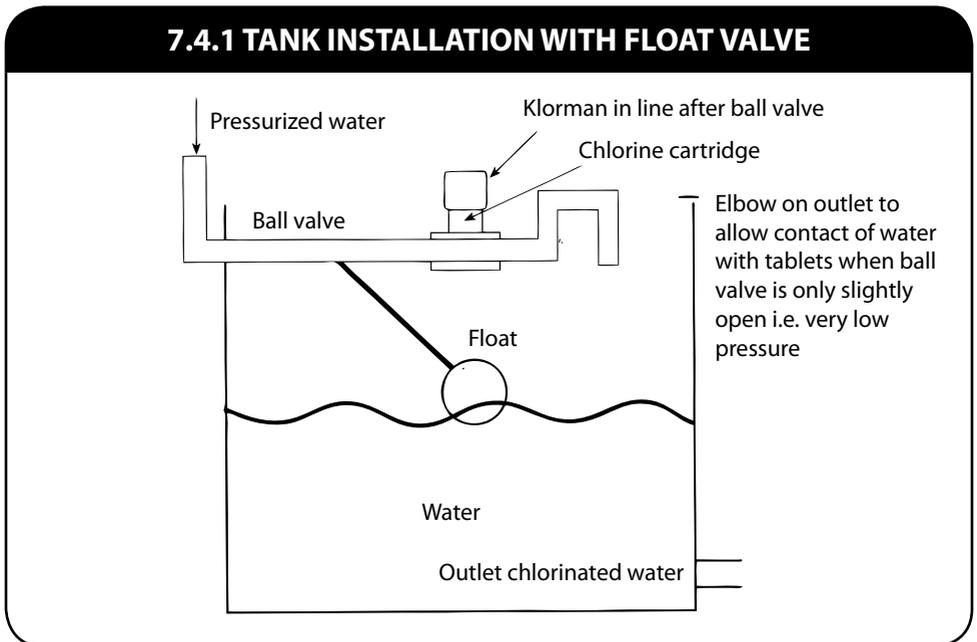
In order to achieve the low levels of chlorine of (1-6 ppm) associated with drinking water applications, it is important to reduce the pressure within the cartridge chamber. To achieve this, the 1¼" US thread OR the 1 ¼" Imperial (50 mm ID) fittings are provided. By increasing the diameter there will be less restriction on water flow through the unit. To prevent bursts of concentrated chlorine in the line upon start-up, as well as continuous soaking of the cartridges, the Klorman unit must be installed on the terminal end of an open waterline or, in the case of wells (boreholes), it must be installed in such a manner as to ensure drainage of the unit when not in use.

Depending upon the pressure in the feed line, the degree of contact between the water and the tablets can be manipulated in the following way:

- If the pressure is very low, install the unit so that it has a large inflow aperture and a smaller outflow aperture. This will create backpressure and will assist the water level in reaching the chlorine tablets. This may be further enhanced with the additional installation of a vertically directed 90° elbow at the outflow end. A further 90° bend can then be directed back down toward the reservoir with additional fittings in order to create a siphon effect so that, when water flow stops, it will drain away from the chlorine tablets.

7.4.1 Tank installation with float valve

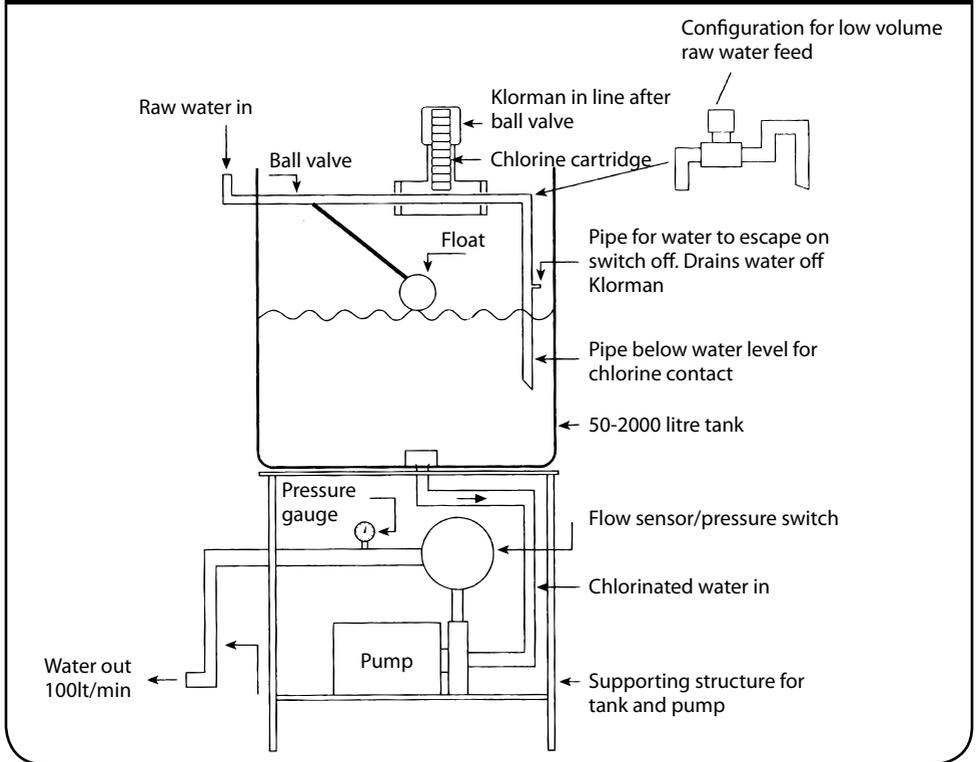
Used in small hotels, industry, households or agricultural requirements where water pressure is



high and/or variable. The unit should be installed at the top inlet to the reservoir or holding tank. Install a ball valve or solenoid switch before the Klorman®.

- Pressurized feed water is fed through an open-ended system that makes it possible to achieve reliably low chlorine levels. As water is drawn out of the tank, the ball valve opens and feeds chlorinated water. When ball valve closes, the water drains and the tablets remain dry.
- When feed water has very low pressure, an elbow must be installed at the outlet side to ensure contact between water and the tablets.

7.4.2 TANK INSTALLATION WITH FLOAT VALVE/SOLENOID VALVE AND RE-PRESSURIZATION PUMP



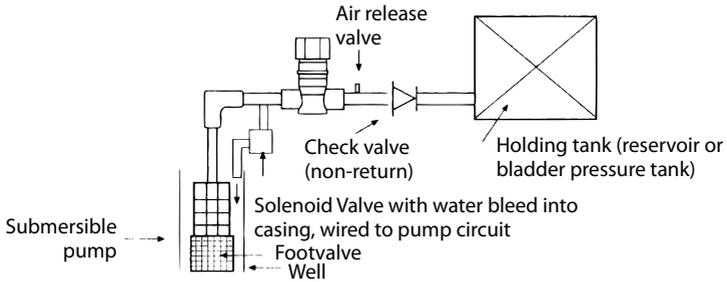
7.4.2 Tank installation with float valve/solenoid valve and re-pressurization pump

This installation provides an open-ended outlet to the Klorman™, which also allows for low-level chlorination like the tank installation with float valve shown above. This installation is particularly suited to high-pressure lines where the Klorman™ cannot be installed inline. As mentioned, when the Klorman™ is installed directly inline the tablet chamber will flood, resulting in unwanted high chlorine levels. The chlorinated water is then re-pressurized in applications where large volumes

of water, or high pressures are required.

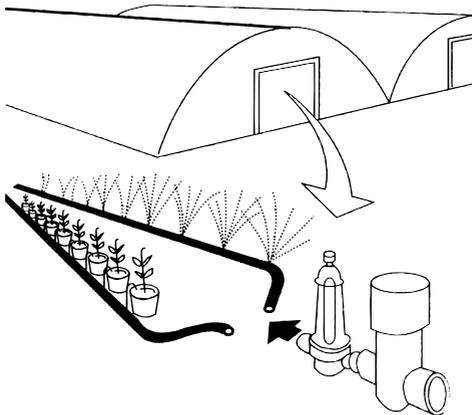
7.3.3 KLORMAN WELL INSTALLATION

SHALLOW WELL i.E. Footvalve



Note: When pump switches off, Solenoid Valve opens and allows drainage of water from system to prevent soaking and softening of tablets

7.5 GREENHOUSES AND NURSERIES



7.4.3 Well/Borehole Installations

7.5 Greenhouses and Nurseries

7.5.1 Chlorination of fertilized recycle water in hydroponics:

Chlorine combines readily with nitrogen to form chloramines. This also applies to nitrogenous fertilizers used in hydroponic applications. Consequently, only very low chlorine concentrations should be used in order to effect chloramination (i.e. 2 - 5 ppm), since higher concentrations of chloramines will burn root systems. In addition, chloramines are of low sanitizing value compared to free chlorine. See also Table 9.1 on Page 18. In this application, the Klorman™ unit should ideally be installed on the return waterline into a recycling catchment tank, and ahead of the fertigation adjustment tank. In the absence of a catchment tank, the Klorman™ should be installed at least 5 meters ahead of fertigation adjustment tank. If the water pressure exceeds 40 PSI, a pressure-reducing valve should be installed ahead of the Klorman. The long active life span of chloramines may result in a build up of chloramine levels in small hydroponics systems. Installing the Klorman™ by-pass, together with a timer switch that will divert water through the Klorman™ for a limited time daily will ensure effective chlorination without a build up of chloramines. Again as indicated under other headings, Klorman should be installed in such a manner that water can drain when water flow ceases.

7.6 Klorman used as Substitute for Immediate Post Harvest Cold Processing of Fruit or other Produce.

It is accepted practice to cool fresh fruit and vegetable produce after harvest to remove field heat. This process is also considered to slow metabolic activity. An important, but generally ignored consequence of such cooling is the effect that it has on spoilage organisms, which are drawn into the fruit or vegetable through harvest wounds under the effect of capillary force. This particularly relevant in crops such as asparagus (*Pseudomonas*), Table Grapes and Mangoes (Stem Rot), sweet corn and many other crops. Prevention can be effected only through mending of harvest stem lesions and bruising. Using the Klorman™ as a pre wash with ambient temperature water after harvest will arrest the negative effects of this capillary force, because the Hypochlor® chlorine will not only immobilize cell rupture enzyme activity, but also leave calcium residual which would enhance cell wall integrity. Cooling should therefore be employed as the final, rather than the immediate activity after harvest in the process line.

The Klorman™ unit should ideally be installed in the field - ahead of transport to the pack house - to arrest harvest bruising and wilting at source. This is particularly relevant to lettuce, which, even when cooled, is still subject to wilting.

Chlorine is delivered ahead of the application, and loss of active chlorine will not occur. Any natural water source such as dam or river can be used. An inexpensive structure can be fabricated from PVC piping and wooden frames, for either transport as shown, or erected at low level for drenching of small crates. Spray holes can be drilled in PVC piping, but it is suggested that standard, custom PVC saddle type shower/rose head sprayers be used which would deliver dense water coverage.

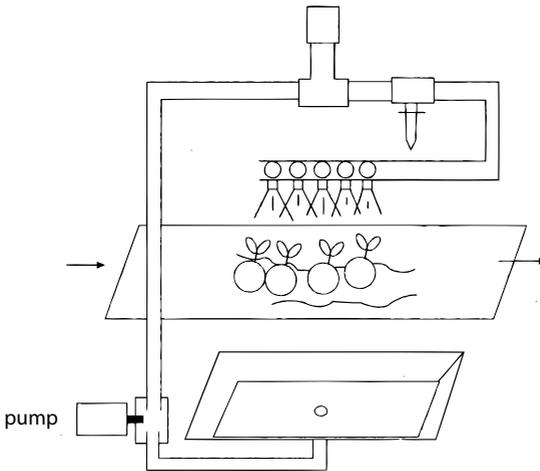
IMPORTANT NOTE

Klorman™ must be installed in order for unit to drain when not in use. In the Figure above it is shown as installed at elevated level to indicate need for drainage. If installed at water source below sprayers, unit must be isolated and a drain valve installed as shown in Figure 7.2 as either manual or solenoid applied system.

7.7 Spray Bar Application for Post Harvest Protection of Fresh Produce.

Unit can be installed on re-circulating line as in Figure 7.7.1, or on a fresh waterline as in 7.7.2. Note adjustment of Unit always to be on the first or LOW line. Generally at average mains pressure the Unit would provide on average 20 ppm of free chlorine at this adjustment. When installed on re-circulation systems, water needs to be replenished regularly to prevent an inordinate increase in pH of the water, as well as to overcome the effect of dirt introduced to the

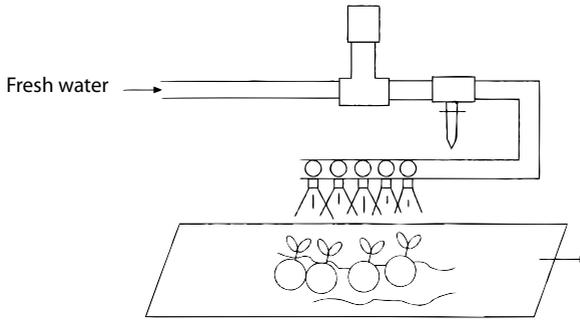
7.7.1 PACKSHED CHLORINATION FOR SORTING AND PACKAGING LINES



water by the produce that is being washed. Note that the Klorman™ should be installed above the spray bars to allow drainage when water is turned off.

Klorman ideally installed on a fresh water line where Hypochlor can be made available at optimum efficiency in terms of pH in rendering hypochlorous acid, and also preventing the intervention of organic dirt.

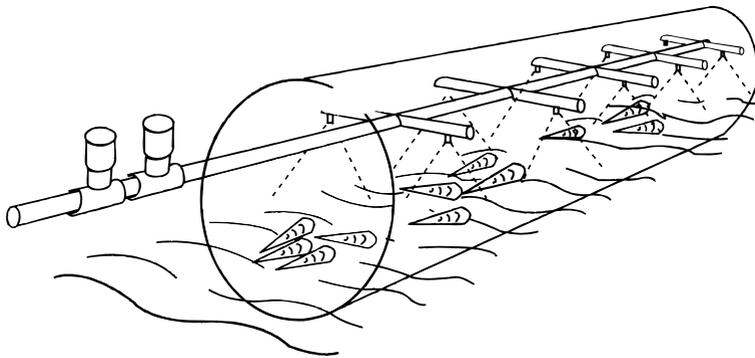
7.7.1 PACKSHED CHLORINATION FOR SORTING AND PACKAGING LINES



NOTE: Hypochlor Chlorine if used effectively at pH 7-8 this effected by using mains water in the system, the hypochlorous acid generated would be highly effective in not only sealing bruises and lesions, but also pesticide residues which contain metals or molecular nitrogen would effectively be degraded.

7.8 Carrot Washers

7.8 CARROT WASHING DRUM



Two Klorman™ Units Installed In Waterline At Standard Mains Pressure 60 Psi.
Each Unit Delivers 25-50 ppm Chlorine. Optimum Efficiency, No Loss Of Chlorine.

8 Klorman™ Test Kit and Determination of Chlorine Levels

8.1 The Concept of Chlorine Demand and Continuous Chlorination

- When chlorine is applied as sanitizer, it is consumed in the process by matter such as debris, surface pollutants and organic residues that are present in the solution. The quantity of chlorine consumed is known as the chlorine demand of the system, and may vary significantly depending upon the type of application or quality of water in the system. It is therefore futile to dose, for example, levels of 5ppm chlorine solution when the requirement or demand may be 50 ppm.
- Chlorine activity is determined by contact time. The shorter the contact time, the higher the concentration of chlorine required to achieve the same result. This can be illustrated by the simple Concentration/Time (CxT) ratio below.

Eg: 1 ppm chlorine concentration x 10 minutes contact = 10
10 ppm chlorine concentration x 1 minute contact = 10

- Once the chlorine demand of the system has been satisfied through the use of calcium hypochlorite, the remaining free active chlorine residual in solution will have no taste and will be odourless. In fact, the strong odor associated with the use of chlorine is due to the formation of malodorous chloramines. When this odor is present, it indicates insufficient chlorine levels to satisfy the chlorine demand, which causes chemical bonding between the chlorine and nitrogen, resulting in the formation of chloramines. This reaction is often encountered in meat, poultry and fish sanitizing, as well as in drinking water applications where nitrogen pollutants are present. The Klorman™ is able to overcome this problem, because it continuously replenishes the consumed chlorine in a waterline. This renders Klorman Hypochlor solutions effective at low concentration levels, mostly recommended by our company for use at 20 - 50 ppm.

8.2 Determining and Monitoring Chlorine Concentrations

The concentration of chlorine in a sanitizing solution is expressed as parts per million (ppm) or milligram per liter (mg/l). It may be confusing to try and equate the dosage levels used in chlorination with those that apply to organic sanitizers, since these are dosed at vastly higher concentrations compared to chlorine. For example, organic sanitizers are dosed at levels of 0.5% or 1%, even 5%. By comparison, one part per million in percentage terms represents one thousandth of 1% (or 0.0001 %). Despite this miniscule quantity, chlorine concentrations are considered to be easily controllable within narrowly defined limits such as 6 or 8, or 20 to 30 ppm. This simply is not feasible, and has resulted in confusion and misunderstanding over the proper application of chlorine in practice. When using the Klorman™ inline system, water surges may cause the chlorine concentrations to fluctuate intermittently. Below at pH 8 can be noted in Table 9, low levels of HOCl, the effective sanitizer can be available in such solutions. The Klorman renders chlorine on a continuous basis with relatively low influence on pH of input water. For instance, if input water pH is 7.4, the chlorinated water derived on the LOW setting of 20-50 ppm (depending pressure fluctuations) would increase to approximately pH 7.8.

8.2.1 The Important Role of pH to Determine the Effectiveness of Your Chlorination Program

It is a property of all chlorine sanitizers that, when they are dissolved in water, the active ingredients are usually present in equilibrium between two sanitizing compounds, namely Hypochlorous acid (HOCl), and the Hypochlorite ion (OCl⁻). As a sanitizing agent, hypochlorous acid is more effective than the hypochlorite ion by a factor of 120 times. The balance of this equilibrium from one compound to the other is governed by the pH of the solution as illustrated by the table below. This table clearly illustrates the importance of maintaining pH levels at an optimal rate in order to derive the maximum percentage of hypochlorous acid versus hypochlorite ion possible for the system in question.

TABLE 9: The Effect of pH on HOCl vs OCl Equilibrium in a Chlorine Solution

pH	% HOCl
4 and below	100.00
5	99.7
6	96.8
7	75.2
8	23.3
9	2.9
10	0.3
11	0.03

8.3 Testing for Chlorine

8.3.1 Test Methods

The generally applied methods used to determine chlorine levels in the process industry are the DPD (Di-Phenylene Diamine), Sodium Thiosulfate and Potassium Iodide Paper Strip Methods.

Potassium Iodide Paper Strip Method

The chlorine test widely used on the farm and in the process industry is the Potassium Iodide/ Starch paper strip method. The test method is qualitative in that it indicates only the presence of chlorine, and not the quantity of chlorine present.

The Klorman™ DPD Chlorine Test Kit:

The Klorman™ Test Kit contains DPD No 1 powder, and therefore determines only the free chlorine residual. It also contains a Ferrous Ammonium (FAS) titration agent, and a Phenol Red pH test solution with an appropriate pH color-comparison chip insert. The larger of the two test receptacles is used to test for chlorine. You will note that the chlorine test receptacle has indicator lines printed at its upper and lower points. These indicator lines are for the purpose of diluting the chlorine test water samples when testing for very high levels

of chlorine (see box below). When the DPD powder is introduced to a solution containing free chlorine, a pink color will develop. The intensity of this color is related to the level of chlorine present. The actual concentration can be determined by adding the Titration Solution provided in the test kit. The addition of titration fluid will cause the pink color to disappear. The number of drops used to remove the color indicates the concentration present

NOTE: If no pink color develops despite chlorine tablets being visibly present in the cartridge, the concentration of chlorine in the water line may be so high that the indicator powder is bleached away. When this occurs, the user must take care not to construe this as indicating that chlorine is not present.

9. The Advantages of Klorman™ Hypochlor® Chlorine Over Liquid Chlorine Bleach

- Hypochlor® is a more efficient sanitizer than liquid chlorine, since a far greater percentage of its available chlorine content is released as hypochlorous acid (HOCl) in solution under operational conditions. Liquid chlorine has a propensity to release a greater percentage its available chlorine content as either hypochlorite ion (OCl^-), or monochloramine (NH_2Cl). The table below illustrates the differences in efficacy between of HOCl, OCl^- and monochloramine for a varied sample of organisms.

The Comparative Germicidal Effect of Chlorine Compounds in Solution

Table 9.1 Concentration of forms of active chlorine to yield 99 per cent germicidal effect in 10 minutes at 25 oC in mg/L or ppm

Organism	HOCl Hypochlorous acid	OCl^- hypochlorite ion	NH_2Cl Monochloramine
E coli	0.005	0.6	1.0
Polio virus	0.002	>>1.0	25.0
Cysts	2.00	800.0	10.0
Shistosomes	0.5 - 1.0	-	0.4

- Calcium hypochlorite in solution is stable over a wider pH range than its sodium bleach counterpart. The high solubility of sodium gives it a propensity to readily elevate pH levels.
- The calcium salt released by Hypochlor® is non-corrosive. The strong ionic character of liquid chlorine often leads to electrolytic galvanic corrosion of pipe work and equipment necessitating the use of special metals at the point of application. In addition, liquid bleach will attack and weaken substances such as glass, porcelain and aluminum.
- Calcium hypochlorite based chlorine does not saponify fat, and can readily be applied at levels above 50 to even 100 ppm in food or environmental hygiene applications. Liquid chlorine saponifies, causing slippery floors, equipment and work areas.

10. Calcium Hypochlorite and the Environment

The effect of Calcium, the Hypochlorite ion and Chlorides on Soil and Plants

Fears are often expressed at the possible influence of calcium and other chlorination residues on the long-term structure of the soil. As far as the use of Calcium Hypochlorite is concerned, such fears are unfounded, since calcium represents the largest single component of all of the elemental nutrients within plant foliage, and forms the building block of all plant cell walls by strengthening the integrity of middle lamella pectin components. The active ingredient of chlorine (hypochlorous acid) does not combine or enter into chemical reaction with plant carbohydrates. In fact, the widely held belief that chlorine damages plant foliage or fruit is incorrect, and is based upon the historical use of liquid chlorine bleach. Bleach is a caustic soda based chlorine source, and releases large amounts of sodium, which displaces calcium from the cell wall and results in deterioration of the protective cellulose outer cuticle of both foliage and fruit. Calcium is beneficial to soil, and the established practice of liming the soil with an array of calcium salts in order to elevate the pH illustrates this fact. Calcium also promotes the solubility of many nutrients in the soil and renders them more easily utilized.

In 1954, the chloride anion residue derived from expended hypochlorite was accepted as being a plant nutrient. In later years it was confirmed as being an essential nutrient, due to the fact that plants probably need more chloride than almost any other micronutrient (with the possible exception of iron). The reason for this may be found in the fact that chlorides are abundantly available in nature. As a principal constituent of seawater, chlorides are entrapped in sea spray and carried by winds for vast distances. Rainwater is a therefore a continuous source of chlorides. The only area where chlorides are considered to have a potentially negative effect in soil is where it has accumulated with other salts, usually in saline soils or where saline lakes are used for irrigation purposes.

11. KLORMAN™ TROUBLE SHOOTING GUIDE

11.1 Little Or No Chlorine Reading Despite Chlorine Tablets Visibly Present In The Cartridge

- a) Calcium residue could form a sediment/crusty barrier between the cartridge seal ring and the Klorman™ body sidewall that may restrict the water from entering the cartridge chamber. This usually occurs on low-level drinking water applications when units are used continuously without regular shutoff of the system. To correct this, unscrew the cap partially and turn water flow ON and OFF briefly. This will allow water pressure to “bump” cartridge up and down and dislodge any sediment. When using Klorman™ in continuous dosing applications, it may be advisable to move/dislodge the cartridge on a daily basis before working shifts.
- b) Chlorine is bonded, and cannot react properly with test reagents. If you are satisfied that your test sample has been properly diluted and no chlorine reading or pink color can be detected with DPD No 1 powder, try adding iodide crystals. If a pink color develops, it will confirm that the chlorine is bonded. This condition will only occur when chlorine is applied and tested on for example wash water used in poultry evisceration.

11.2 Cartridges Are Difficult To Insert Or Remove

Hypochlor® chlorine is calcium-based, and therefore deposits small quantities of calcium residue inside the cap, chamber and threads. Over time, this residue may restrict movement of and around these parts, but it can easily be removed through brushing with a diluted solution of muriatic/hydrochloric acid. This is non-toxic and will not affect water quality or produce.

11.3 Water Leaking Through Teflon Seal Between Klorman™ Body And Cap

The white Teflon seal located at the upper end of Klorman® Body provides an airtight compartment which ensures that only the bottom tablets come into contact with the water flow. This is particularly important for low-level chlorine dosing. If the Teflon seal is faulty and water does flood the cartridge chamber, the tablets will be inclined to swell and disintegrate in an uncontrolled manner. When this occurs, the Teflon seal and black “o” ring should be replaced. When replacing, ensure that the groove on the Teflon seal is in the upper position.

11.4 Klorman™ Cap Shatters Or Cracks Repeatedly

Klorman™ caps are molded from high impact, durable plastic compounds and can easily withstand the pressures found in most standard water lines. Nevertheless, in systems that are prone to repeated pressure surges, these surges will result in flexing of the cap and may weaken the plastic at the corners over time. If your system has such surges, try installing a hollow shock-absorbing pipe into the line just ahead of the chlorinator.

NOTES

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