Calcium Hypochlorite Tablet Chlorination: Fact or Fiction?

Tablet chlorination, used as an alternative to the traditional chlorination methods of gas and liquid, provides a unique combination that accurately and safely delivers chlorine to drinking water systems; however, there are many misconceptions that pervade the potable water industry obscuring the facts. Using simple chemistry and engineering, it can be explained why and how tablet chlorination, along with the use of calcium hypochlorite tablets, can be a safe and cost-effective method for water treatment.

By Scott Betcher

Why tablet chlorination can be a safe & cost-effective alternative to the traditional chlorination methods of gas and liquid

The Importance of Alternatives

In the drinking water industry, chlorine gas and liquid bleach have long been the standard chemical used in water chlorination and disinfection. The practice of using chlorine in drinking water treatment has been acclaimed as one of the most significant public health advances of the 20th century, if not the entire millennium. More than 98% of water treatment plants use some form of chlorine to treat their water because of several benefits: germicidal potency, sustained residual disinfection properties, taste and odor control, as well as it being cost-efficient. In the past few years and more recently with the signing of the Bioterrorism Act by President Bush, the federal government has increased the effort to keep this nation's water supply safe. Disinfection of the public water supply should not be compromised.

Water suppliers are continually being challenged to prevent the presence of disease-causing microorganisms in their water systems and methods of treatment vary depending on site-specific factors, as well as the quality of the raw water supply. The importance of water disinfection is evidenced by the fact that most past cases of outbreaks of waterborne diseases were due to inadequate disinfection or no disinfection at all. Alternatives to the use of chlorine have received increased interest because concerns over the formation of disinfection byproducts (DBPs) have emerged; however, most of these alternatives (i.e., chloramine, chlorine dioxide and ozone) also produce DBPs. Less is known about the DBPs formed by some of the alternatives, and the risks using these technologies may be equivalent or higher. Chlorine is still the most common drinking water disinfectant used today and the one we have the most information about. On balance, the health risks of not chlorinating water appear to be greater than risks associated with DBPs.

Emerging national security issues, along with having to comply with other federal regulations such as EPA's Risk Management Plan and OSHA's Process Safety Management, have pushed the water and wastewater treatment industry to look for alternatives. Alternatives like ozone, UV irradiation and chlorine dioxide have been used.

Although these other processes do provide efficient disinfection capabilities, each alternative has associated disadvantages. Ozone and UV irradiation do not provide a persistent residual disinfection capability and have relatively high operating and maintenance costs associated with them. Chlorine dioxide forms organic byproducts and requires onsite generation equipment and the handling of several chemicals.

Chlorine's Benefits & Disadvantages

As mentioned before, chlorine has many benefits. First, the use of chlorine has been demonstrated to reduce the level of microorganisms that cause waterborne

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TABLE 2: Cost Entry

Cost Entry

Chemical Costs

Gas Cost	($/lb)	
Tablet Cost	($/lb Tablet)	
12% Bleach Cost	($/gal)	
Cost of Capital	(APR)	
Burden of Labor	($/hr)	
Power Cost	($/kWH)	

Chlorine Usage

Residual Req'd	(ppm)	

Operating Data

Flow Rate	(GPM)	

Est. Annual Chlorine Usage (lb)

Gas Chlorine

Basic Equipment Cost		$
Safety Equipment		$
Replacement Parts		$/yr
Maintenance		hrs/wk

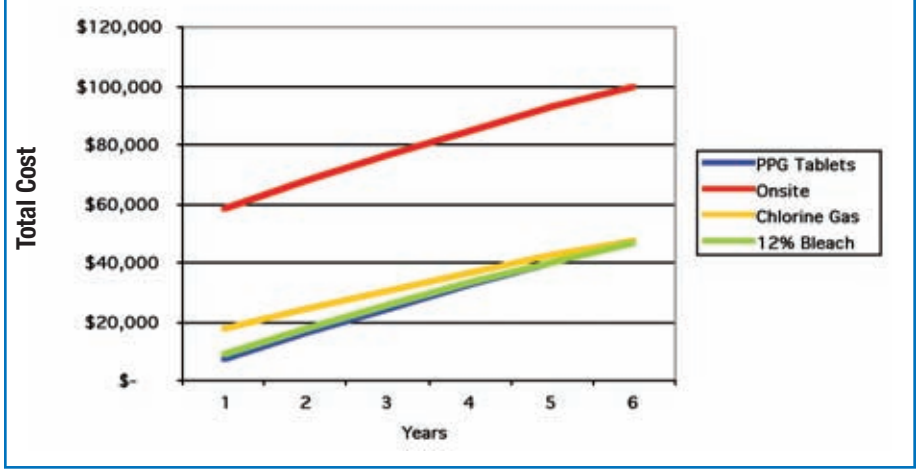
12% Bleach

Basic Equipment Cost		$
Sec. Spill Containment		$
Assay Loss Coefficient		fraction
Replacement Parts		$/yr
Maintenance		hrs/wk

Solid Chlorine

Basic Equipment Cost		$
Replacement Parts		$/yr
Maintenance		hrs/wk

FIGURE 1: 5-Year Cost Comparison



An actual analysis utilizing this tool based on a 1-mgd plant requiring a 1-ppm residual. As demonstrated by this five-year, total cost comparison, calcium hypochlorite tablets in this case are economically competitive with the other products.

diseases. It is easy to apply, and small amounts stay in the water from the treatment plant through the distribution system to the consumer's tap. Chlorine also controls biological growth by eliminating bacteria, algae and other organisms. Because chlorine oxidizes natural substances such as decaying vegetation, reduction in odors and tastes can and do occur. For these reasons, chlorine is still the preferred solution of drinking water experts.

Typically, two well-recognized forms of chlorine have been used in water treatment: the use of chlorine gas in cylinders and sodium hypochlorite (bleach) solutions. Due to the physical nature of these chemicals, both of these technologies present specific safety concerns about potential releases and spills, and both typically require special buildings and spill containment designs. These chemicals also present handling issues that need to be considered. For example, chlorine gas requires personnel training and use of personal protective equipment when changing cylinders. Similarly, handling drums of bleach is difficult and presents safety issues.

TABLE 1: Alternatives

Chlorine gas:

$$Cl_2 + H_2O = HCl + HOCl$$

Liquid Soda Bleach:

$$NaOCl + H_2O = NaOH + HOCl$$

Calcium Hypochlorite (solid):

$$Ca(OCl)_2 + 2H_2O = Ca(OH)_2 + 2HOCl$$

(All three produce the same active sanitizer. HOCl disinfects, sanitizes and provides residual protection.)

Maintenance costs are another factor. Keeping chlorine gas eductors and bleach addition pumps operating efficiently is a chore because the equipment's small orifices are prone to clogging. Bleach loses strength and efficacy over time that can result in increased material costs to keep residual disinfection capability in the system.

The Alternative

In looking for alternatives, one needs not go far from the traditional forms of chlorine to find one. Water treatment facilities have been turning to another form of chlorine—calcium hypochlorite—as their system for water chlorination. Calcium hypochlorite dissociates in water and hypochlorous acid is formed. As with chlorine gas chemistry, hypochlorous acid is the disinfecting agent.

Calcium hypochlorite is an attractive alternative to chlorine gas or sodium hypochlorite (bleach) solutions because it is a dry form of chlorine that offers several handling advantages. Calcium hypochlorite contains approximately 65% available chlorine, compared to the 12% in bleach, and does not require operator certification or containment areas. Many facilities have opted for a technology using calcium hypochlorite tablet systems as the preferred method of introducing chlorine disinfectant. This technology is selected because of its lower capital costs, accuracy, reliability, safe handling and maintenance benefits. It has opened up new horizons in water chlorination for applications of many types and sizes. Calcium hypochlorite systems have been used for years and are currently being used for primary disinfection treatment or as a remote booster chlorination stations.

The Accu-Tab tablet chlorination system from PPG Industries combines calcium hypochlorite in 3-in. tablet form along with a specifically designed patented erosion feeder. Incoming water from a side stream contacts only the tablets at the bottom of the feeder so remaining tablets stay dry and do not dissolve prematurely. Calcium hypochlorite tablets erode at a predictable rate that is dependent upon water flow to the unit; therefore, highly accurate chlorine dosage can be achieved by controlling the water flow rate. The chlorinator effluent is then returned to the main system flow providing the desired level of available chlorine to meet operational requirements. Tablet chlorination systems can be fully automated utilizing compound loop, residual control or flow pace control, similar to chlorine gas or sodium hypochlorite systems. These systems have been used to chlorinate water plants as large as 14-mgd that have chlorine demands exceeding 400-lb per day. On the other end of the scale, smaller units have turndown ability to supply the 35-gpm well water user without over-chlorination. The chlorinator has no moving parts, requires little maintenance and provides long-term reliability. The feeder with the designated 3-in. tablets provide the total solution for water and wastewater treatment.

Cost Comparison

On the surface it may seem calcium hypochlorite tablet systems cost more to operate than other chlorine systems. For a true cost evaluation, an economic analysis should be conducted that considers the total cost of the system. The evaluation should consider capital costs as well as maintenance and operational costs. One may be surprised by the results of the economic analysis. Table 2 is an example of an economic analysis spreadsheet, developed by PPG Industries.

Surprising Results

Calcium hypochlorite tablet chlorination has proved itself as an alternative to the traditional chlorination methods of gas and liquid. Tablet chlorination systems accurately and safely deliver chlorine to drinking water systems. Upon considering alternative chlorination methods, thoroughly evaluate the cost of operation through economic analysis tools. You may be surprised by the results.

Calcium hypochlorite tablet erosion chlorinators and tablets meet federal requirements including the NSF standards 60 and 61 for drinking water, American Water Works Association B-300 and several USDA standards.

The tablet chlorination systems are currently being used for drinking water applications in over 40 states as the primary disinfection treatment or in remote booster chlorination stations. As regulatory requirements and safety issues provide more of an incentive for water treatment plants to reconsider their water treatment systems, it is important to recognize that calcium hypochlorite offers safety and low maintenance benefits together with small capital investments. Calcium hypochlorite technology is making the difference in municipalities around the country. *wqp*

About the Author

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