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DISINFECTING WITH GAS CHLORINE

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Disinfection of treated water with gas chlorine remains a common technique to ensure the production of safe drinking water. Recent surveys indicate that as of October 2008, the date of the latest AWWA published report on this topic, 63% of respondents used gas chlorine as a disinfection agent. Safety concerns remain with the use of gas chlorine, however, and Plant Operators are required by Federal, State and local codes to prepare safety, emergency and response plans that are updated on a regular basis. The experience of several water treatment plants in California, Texas and Arizona may be of help to those facilities that are thinking of upgrading their disinfection system to a gas chlorine type installation.

Gas Chlorination - The Experience at Selected Sites

The Town of Queen Creek, Arizona operates tablet chlorination systems at each of its 15 well sites. Discussions with engineering staff revealed that a considerable amount of time is spent by operations staff in adjusting, maintaining and responding to alarm conditions at these sites. It is estimated that operating the tablet chlorination system accounts for 16 to 20 hours of an Operator's time per week to maintain the existing Queen Creek system. The Town is actively considering the phased replacement of the existing tablet chlorination system with a gas chlorine system because of its high efficiency. A gas chlorine system provides 100% chlorine disinfection to the point of delivery, and has a low operating cost. A typical system relies on an eductor system that pulls chlorine product from a cylinder; there is no pumping. There are also no pretreatment requirements of the water such as softening or on-site generation of a disinfectant requiring the mixing and electro dialysis of chemicals and their handling. Safety and leak protection would be provided by the placement of 150-pound or 1-ton cylinders in a containment vessel as manufactured by TGO Technologies.

The City of Yuma, Arizona operates a gas chlorine disinfection system at its Agua Viva and Main Street Water Treatment Plants. The gas chlorine cylinders at each plant are placed in an enclosure that uses a dry scrubbing system to mitigate any leaks. There have been no measurable leaks recorded at either plant site since the installation of the gas chlorine system in 1999. The City recently completed an evaluation of the use of alternate disinfection techniques to replace gas chlorination, a technology that is perceived by some to be unsafe and of high risk. On-site generation of sodium hypochlorite was seriously considered but it was noted that this technology

has the disadvantage of generating chlorates, a disinfection byproduct (DBP) that is of special concern to the United States Environmental Protection Agency (USEPA) and health professionals because of chlorate's capacity to impair the body's ability to carry oxygen. A recent study by the USEPA indicates that approximately 37% of public water systems have chlorate levels above the health reference level of 210 ug/L[1)], making it a contaminant of concern. The City of Yuma decided to maintain its current use of gas chlorine as a disinfection system because the use of this technology generates a minimal amount of chlorates in domestic water.

The City of Benecia, California water treatment plant has a design capacity of 12 MGD. Its gas chlorine system was installed with the plant's inception in 1971. Up to four (4) 1-ton cylinders are stored on-site at any one time, all housed in secondary containment vessels (TGO Chlortainer). The chlorinators are flow paced and rated for 0 – 100 pounds/day for pre-chlorination and 0 – 300 pounds/day for post-chlorination. A 1-ton container is drained in approximately three weeks. Safety features for the containment vessel include an automatic shutoff valve and a vacuum breaker-regulator that shuts off gas if a leak in the downstream piping is discovered. Operator training is taken very seriously and staff is continuously trained on the proper methods of loading and unloading gas chlorine cylinders. USEPA mandates the preparation of a Risk Management Plan (RMP) for facilities that equal or exceed 2,500 pounds of gas chlorine at any one time. The City of Benecia has taken a proactive role in preparing and updating these RMPs and works closely with USEPA Region IX. The City has no plans to replace its gas chlorination system and has found it to be economical because no other technology provides as much service for its cost.

The City of Houston, TX is currently engaged in the retrofitting of containment vessels at five water production facilities throughout its system that currently use gas chlorination for disinfection. These sites draw raw water from both surface and groundwater sources and the dosing options include delivering chlorine to storage reservoir fill lines, and/or of dosing delivery lines downstream of the booster pumps, should chlorine residual monitoring measure low residuals. Ten (10) containment vessels will be procured as part of the first phase of this program. Each gas chlorine cylinder will be housed in its containment vessel whether on line and actively dosing or as a spare waiting for a switch-over when the lead vessel is empty. The containment vessels offer an economic advantage when compared to dry scrubbers in that vessel maintenance consists only of servicing the nitrogen gas fail-safe solenoid valves, the vessel door's o-rings, vacuum tubing, and chlorine transfer hoses on an annual basis. In comparison, a scrubbing system requires maintenance of the blowers, media, controls and electrical systems. Also, replacement of the media must be done on a regular basis and care must be taken to not exceed the threshold quantities for hazardous material disposal when replacing the spent media.

Regulatory Viewpoint

As previously mentioned, the use and storage of gas chlorine requires the operator to prepare various emergency and safety plans promulgated by the USEPA and others. Process hazard analyses meeting OSHA's Title 29 Chapter 1910, RMPs meeting the requirements of 40 CFR Part 68 of the Clean Air Act and also Article 80 of the Uniform Fire Code are mandated. The RMPs are updated every five years. The USEPA offers an interactive website application that is helpful to the Operator in performing this task. It is also possible to participate in training classes sponsored by the USEPA to assist in the preparation of RMPs. The regional USEPA offices are a resource for these applications. Local and state agencies are also a good resource of information and can assist in understanding permitting questions.

The following items should be noted by the applicant prior to submitting to the regulatory agencies:

- Gas chlorine vessels are best stored in an enclosed, isolated room or building.
- When placed in an enclosed space, detection and containment systems may be easily tailored to the particular site configuration.
- Provide a light in the access doors to the chlorine storage space to allow an Operator to glance into the room without entering.
- Local alarming is a minimum. Site control and data acquisition (SCADA) and remote alarming capabilities are recommended to maximize public safety and reduce response times should an event occur.
- Place the required placards in a visible location outside the chlorine storage room.
- The use of self-contained breathing apparatus (SCBA) is recommended when switching the chlorine vessels.
- Provide the local first responders and fire department with accurate information. Conduct yearly inspections with first responders.
- It was noted by a site inspector for the Maricopa County Environmental Services Department, (MCESD) the regulatory agency responsible for the inspection of water treatment plants located in Maricopa County, AZ that in 10 years of service, MCESD has not responded to any gas chlorine leaks at water treatment plant. However, two explosions have occurred at plants with on-site generating systems, caused by the accumulation of hydrogen gas, a byproduct of the electrolysis process of creating sodium hypochlorite.

Conclusion

Operating a gas chlorine system requires a robust training and safety program. The regulatory oversight is significant but the preparation of RMPs and emergency plans are well established and available on line from the regulatory community such as USEPA for assistance. Worker and community safety will be obtained from dry scrubbing or containment vessels; however, the

passive containment of chlorine leaks in an ASME rated vessel provides for the most positive control.

A discussion with Public Water System operators in 3 states indicates that the disinfection of water with gas chlorine may be safely and economically performed. It offers significant advantages of providing the highest service for its cost of any other disinfection process as reported by these PSWs[2)]. Gas chlorine remains a viable disinfection option that is available to the Water Treatment industry.

1) Taken from Something in the Water – Determination and Prevalence of Chlorate in U.S. Drinking Water by Jack, Richard, et al.; WaterWorld, Vol. 32, Issue 2; February 2016.

2) See also The Benefits of Chlorine Chemistry in Water Treatment; Whitfield & Associates, December 2008; American Chemistry Council