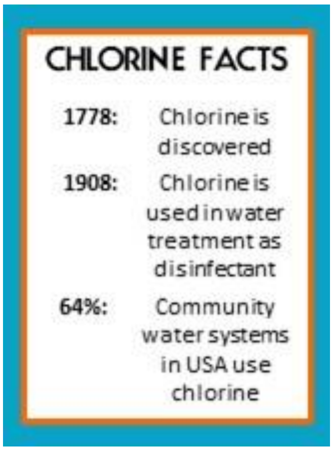
To switch or not to switch - that is the question

Four things to consider before switching from chlorine gas to hypochlorite for residual disinfection

Introduction



Is your utility considering switching from chlorine gas to hypochlorite for residual disinfection? Concerns about the safety of your gas-based system may have you considering a change to a hypochlorite-based system. Is safety the only thing you should consider? What other considerations are there?

Chlorine gas has been the method of choice for most major utilities since drinking water disinfection began more than one hundred years ago. Still today, at least two-thirds of drinking water utilities use chlorine gas.

Hypochlorite (bleach) has become the second most common disinfection method. There are issues, however. Degradation leads to loss of strength and increased residuals, making it more difficult for operators to control disinfection.

So, what should a well-managed water authority consider before they switch disinfection systems? The four most important considerations are:

1. Safety
2. Health,
3. Environmental, and
4. Cost

In four posts, we'll explore these important considerations. We'll start with the all-important: Safety.

Consideration 1: Safety

Before any discussion of the actual safety of any chlorine-based disinfection system can begin, it helps to consider the reporting of incidents involving the release of chlorine gas. The media often does not differentiate between chlorine gas leaking from a cylinder or tank of compressed gas and that generated from the mishandling of hypochlorite solutions.

Hypochlorite incidents have been inappropriately attributed to compressed chlorine gas in the media and in government databases. Indeed, up to 65% of reported chlorine accidents involve hypochlorite (see Figure 1). Half of those incidents, when reported in the media, had "chlorine" in the headline.

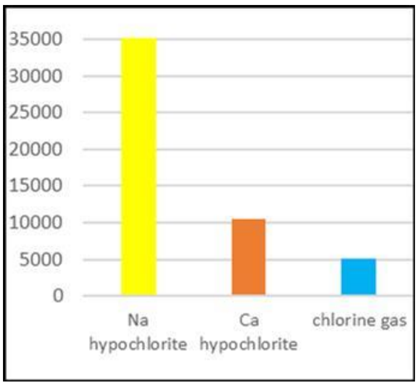


Figure 1: Chlorine exposures in 2006

(American Assoc of Poison Control Center Data, 2006)

Chlorine in any form is hazardous. Safety depends not only on the systems used but also on minimizing the potential for human error. When comparing chlorine gas to hypochlorite, major points of difference occur at:

- Transport and storage
- Point of use
- Regulation

Transport and Storage

Chlorine gas

Because of the hazardous nature of chlorine gas, considerable research and development has been devoted to safety during transport and storage. Chlorine gas is stored in pressurized vessels that are ASME-rated. Pressure release valves prevent tank ruptures in case of fire.

Chlorine gas secondary containment systems significantly increase safety for chlorine gas systems. Cylinders and tanks are housed in a containment system that monitors and mitigate any gas leaks. Any chlorine that leaks out its primary container is held within the containment system. The leaked gas can be fed directly into the chlorinating system from the containment unit without loss of product.

If chlorine gas cylinders or tanks are not held in a containment system, a scrubber may be required. Gas containers are usually stored in a designated room or building that can be isolated in the event of a leak. The scrubber then clears the area of chlorine by absorbing any chlorine gas into solution. A special six-member, trained response team must be available at all times to deal with a leak within the building.

Hypochlorite

Hypochlorite solutions are highly reactive, and few construction materials can contain it. Because it's so corrosive, metals (except for titanium) cannot be used. Tanks, lines, and pumps must also be designed to handle the caustic, viscous liquid.

Oxygen gas is generated during the natural decomposition of hypochlorite. That means hypochlorite storage containers must be vented or be equipped with adequate relief devices. If venting is not adequate, swelling or damage to the container may occur.

Unintentional mixing of hypochlorite with acidic water treatment chemicals such as alum or hydrochloric acid releases chlorine gas. The generated gas must be contained, vented, scrubbed or otherwise dissipated from buildings not necessarily designed for these situations. Hydrogen gas generation adds an explosive risk in these reactions.

Point of use: vacuum vs pressure

Chlorine gas

In a chlorine gas system, chlorine is shipped and stored under pressure as a liquefied gas. Cylinders and tanks feed the chlorine into the water supply as a gas, which is controlled by a vacuum-operated, gas feed chlorinator.

A vacuum, created by passing water through a venturi, pulls the chlorine in and mixes it with water, producing a high-strength chlorine solution. The concentrated solution is then diffused into the water or wastewater to provide the required chlorine dosage. Chlorinators mount directly to gas cylinders and containers and are equipped with shut-off valves. Any loss of vacuum, including a piping leak, will shut off the gas flow, minimizing the volume of gas released.

Hypochlorite

In hypochlorite systems, the hypochlorite solution, at 10 to 15% concentration, is injected into the water stream under pressure. If a leak occurs in a pressurized system, large amounts of treatment solution can be released. Chlorine gas can vaporize from such concentrated solutions, creating a gas hazard.

Hypochlorite dosing systems must be designed to control the release of gas from the bulk hypochlorite in dosing pumps and piping. Oxygen bubbles can form when hypochlorite degrades, locking the suction line in the pump, and reducing or stopping the flow of chlorine solution.

Degradation of the concentrated caustic solution results in scale formation that interferes with the proper operation of pumps and clogs pipes.

Regulation

Chlorine gas

Whether it's due to misleading media reports, misinterpreted data, or actual risks, chlorine gas use is heavily regulated. The chlorine gas industry has always been aware of the safety issues of producing, transporting, storing and using such a hazardous material. The industry established the Chlorine Institute in the 1960s to provide support, training, education, research and development for chlorine users.

The federal government requires water and wastewater facilities that use large amounts of chlorine gas to develop and implement Risk Management Plans.

These risk-based plans identify hazards and assess risks based on the frequency of potential event occurring and the consequences of that event. Unacceptable risks are mitigated through specific actions. The RMPs are reviewed and updated regularly. This level of planning ensures higher safety standards are maintained.

Hypochlorite

Although new regulations are forcing the water industry to recognize issues associated with the use of sodium hypochlorite, on-site safety is not specifically regulated.

New regulations apply to, for instance, the high potential for contaminants such as perchlorate, chlorate and bromate to impact water quality. Environmental regulations apply to the transport and storage of hypochlorite. Discussion next week will focus on human health considerations. In the 3rd post in the series, we examine the potential for environmental harm from transport, spills, and storage breaches.

Conclusion

The decision to switch chlorination systems should be based on a sound understanding of the safety, health, environmental, and cost considerations.

The chlorine gas industry has a long history of focusing on safety. Having been heavily regulated for years, the industry maintains an outstanding safety record. As we have seen, the use of hypochlorite does not mitigate the potential for chlorine gas releases. In next week's post, we will consider the health considerations of a switch from chlorine gas to hypochlorite.

A secondary containment system adds another layer of safety to your gas chlorination operation. Download a brochure today!

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