Top 10 Factors To Consider When Converting To On-Site Hypochlorite

By Flora Vinson and Daryl Weatherup

As a result of increased operational safety and security concerns, the use of chlorine gas has recently come under much scrutiny due to its production, distribution, re-packaging, and transportation in America and other regions around the globe.

Ironically, the same disinfection chemicals that are used to make our public drinking water safe can also pose health and safety risks when misused. Striking a balance between safety, reliability, and efficiency is key to modern treatment plant design and operation.

Liquefied chlorine gas is fully concentrated when packaged in cylinders, as commonly used in the municipal water treatment market. Therefore, transportation costs are lowest on a per-pound of chlorine basis, making this often the most cost-effective option based on chemical costs alone. By comparison, industrial strength sodium hypochlorite (chlorine equivalent) is comprised of 85-90% water and therefore considerably more expensive to transport on a per-pound basis.

Alternatively, transporting pure salt - the raw material needed to generate sodium hypochlorite onsite – is more cost effective, stable, and safer, than transporting and storing bulk sodium hypochlorite, or gaseous/liquid chlorine cylinders from local chemical suppliers. Variability exists in supply chain, safety requirements, and regulations for each municipality so all conditions need to be considered when evaluating these alternatives

The conversion to on-site hypochlorite generation can be achieved by adhering to these design guidelines:

1. Application and Capacity Sizing

   The primary applications for brine-based on-site hypochlorite generation are potable water treatment processes. The On-Site Electrolytic Chlorination (OSEC) system operates on a batch mode cycle that generates and maintains a supply of dilute 0.8% sodium hypochlorite solution. The generators are sized based on average and peak chlorine dosage and flow rates of the plant (to determine daily chlorine demand). To keep the system running in batch mode, generation skids are sized 20-30% above peak chlorine demand to allow for some buffering capacity to perform service, and also to reduce cycle time on the equipment. That way these systems are running only when needed and standby when product inventory is maintained.

2. Water Supply

   The quality of incoming water supply is very important since this will come in direct contact with the electrolyzer process. Calcium and magnesium dissolved in the water can form deposits on the electrode surface which decreases overall efficiency. This is why a water softener is often required to bring concentrations to <17 mg/L (ppm) hardness. The presence of transition metal ions can also affect the quality of the product by encouraging degradation reactions. The water supply must have <1 mg/L chlorine residual and pressure of 45-60 psig (3.1-4.1 bar).

3. Water Temperature Control

   The OSEC system operates efficiently over a wide temperature range of 55-80°F on the inlet water side. Because the electrolysis reactions occurring in the cells generate heat energy, the solution temperature may increase 20°F passing through the system. Control of inlet water temperature is essential to in order to meet and maintain ambient product temperature requirements (50-104°F). If these requirements are not met, a water heater/chiller may be required to bring dilution water to acceptable temperatures prior to the brine tank.

4. Brine Saturator

   Crystallized solar salt is harvested from seawater, salt lakes or brackish water (salt mines) by solar evaporation. These crystals may then be further refined and dried in a kiln to achieve uniform sizing and minimize moisture content. This dry commodity is non-toxic, non-hazardous, and can be safely transported through communities and neighborhoods en route to its final destination at the treatment plant. Salt is most often pneumatically conveyed to large storage and saturation tanks where it is stored ready for use and without harm or hazard to operations personnel. These tanks are typically sized to hold 15-30 day salt inventory. Outdoor installations may also require heat tracing and/or insulation in colder climates to prevent brine freezing. Features included on these tanks can be customized by the needs of the user: ladder/cage, brine level monitoring, tank location, material construction, size, etc.

5. Brine Delivery Method (Brine Pump)

   To ensure optimal hypochlorite generation, a steady, reliable, and accurate brine delivery system is required. Mechanically actuated diaphragm pumps are superior to bellows pumps or eductors for this purpose. With a diaphragm pump, flow rates can be accurately adjusted, unlike bellows pump which offer less control and are less durable. With eductors, flow rate is affected by changes in water pressure so a booster pump and pressure regulating valve would have to be provided in order to maintain steady flow. Eductors offer little to no adjustment either.

6. Hypochlorite Generator

   The rated capacity of the OSEC generator will determine how many electrolyzers are included on each skid. Inside the electrolyzer are cells comprised of anode and cathode plates that remain submerged in an electrolyte solution while operational. Each generator is coupled with a dedicated transformer/rectifier to provide a steady supply of direct current for the electrochemical process. The systems are designed to include all necessary instrumentation and process safety interlocks directly on the skid to ensure a complete, tested, and inherently safe package is supplied.

7. Product Tanks, Ventilation

   Diluted sodium hypochlorite and hydrogen gas flow from the generator to the product tank. These specially lined tanks are typically sized to hold a 24 hour inventory of hypochlorite at peak chlorine demand, and are usually made of polyethylene fiberglass reinforced plastic. Indoor placement is recommended to avoid extreme temperatures and exposure to direct sunlight, however if product tanks must be place outdoors, heat tracing, insulation, and provisions for sun shading are recommended to prevent degradation from UV and freezing at temperatures lowers than 32°F. Important considerations for the product tank are: ventilation ductwork for tanks placed indoors, level sensors, position of overflow nozzles,

pressure transducers, and intrinsic safety barriers inside the tank that will prevent sparks in a hydrogen concentrated environment.

8. Gas Detector and Instrumentation
   Gas transmitters are used to detect and monitor hydrogen gas concentration in room air. They are available and highly recommended. These are generally placed in areas where hydrogen gas may collect, such as the product storage tank room. Recommended installation point is at the ceiling near the top of the hydrogen vent from the product tank.

9. Dosing Pump
   The dosing pump will pace the amount of hypochlorite solution from the product tank to the application point which directly affects the level of disinfection the process water will achieve. It is important to have an accurate and reliable pump to ensure proper disinfection, and also avoid excessive dosing. This pump, coupled with residual monitor device will allow the operator to pace their chlorine dose (or residual) to meet the instantaneous demands of the plant process water flows.

10. Chlorine Residual Monitoring
    Residual monitoring is recommended to maintain required levels of chlorination in the process water, as well and optimize the use of chlorine inventory. For those looking to switch from an existing chlorine or bulk hypo application, the same residual monitoring system in place will typically work. Proper monitoring is critical in achieving good control over the disinfection process. For new applications or upgrades, a full range of chlorine residual monitoring technologies are available from Evoqua.

While there is no one solution that fits all applications, it is helpful to know what parameters to look for when selecting the process that best fits your needs.

We have been disinfecting municipal water for 100 years with our Wallace & Tiernan product family. When it comes time to upgrade your infrastructure with new disinfection technologies, look to Evoqua Water Technologies for solutions in on-site hypochlorite generation, chlorination, chloramination, dechlorination, chlorine dioxide, ultraviolet disinfection, and other alternative disinfection methods.

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Abstract
This article is intended for those who are seeking to maintain chlorine residual as a means of disinfection, and would like to switch from chlorine gas to an inherently safer technology: the conversion to on-site electrolytic chlorination can be a cost-effective alternative with these 10 guidelines in mind.

Keywords
Hypochlorite, on-site generation, OSHG, electrochlorination, disinfection, inherently safe technology, chlorine, chlorination, OSEC, Wallace & Tiernan, alternative disinfection, on-demand chemistry, product stewardship, carbon footprint, Responsible Care, potable water disinfection, municipal water treatment.