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Subject: On-Site Hypochlorite Generation versus Bulk Chemical – Gas, Liquid, and Solid

CHLORINE DISINFECTION APPROACHES

Gaseous chlorine has been a historical disinfection choice for municipal potable water and wastewater systems due to its low commodity cost. However, the hazardous status of chlorine gas adds to its overall cost to account for transportation, storage, and handling. The safety precautions and risks, coupled with recent concerns with respect to terrorism, are leading facilities to consider alternative disinfection methods.

Liquid chlorine, commonly referred to as bleach, is also a common disinfectant and is manufactured at a concentration of approximately 12.5%, for industrial uses, but is typically guaranteed at 10% due to decomposition by the time the product is deployed. Bleach carries a much lower risk than handling and dispensing chlorine gas. However, concentrated sodium hypochlorite is also classified as a hazardous chemical and adds additional cost for the handling, transportation, and storage. Volatile demand for bleach, and rising transportation costs, and degradation over time during storage when combined with instability in supply are leading to a renewed interest in yet another alternative disinfection method.

Solid chlorine, referred to as calcium hypochlorite or HTH, while stable when stored in a sealed container, presents significant hazards and cost in the process of solubilizing to liquid form for dispensing. In general, solid chlorine has a higher cost than liquid chlorine and presents the same subsequent hazards and costs for application as liquid chlorine.

On-site hypochlorite generation has been available for many years. On-site generation (OSG) is the solution to improving cost, safety, supply stability, and personnel risk. With OSG, salt water is converted to sodium hypochlorite at an output concentration that is generally regarded as safe and non-hazardous, i.e., the product is less than 1% sodium hypochlorite.

ON-SITE HYPOCHLORITE GENERATION

The full lifecycle cost of operating OSG involves operational expenses (OpEx) such as brine or seawater, electricity, and maintenance, and capital expenses (CapEx) such as the generator itself along with any required site improvements. Generally, the Capex for an OSG is greater than the annual cost of delivered liquid chlorine. The OpEx, which is predominantly determined by the cost of salt and electrical power, is generally significantly lower than the cost of delivered liquid chlorine. System payback for the acquisition of an OSG often occurs in less than three years.

The costs for raw materials and transportation of delivered hypochlorite and chlorine gas have been climbing significantly over the past few years while the cost of salt and power has remained relatively constant.

OPERATION & MAINTENANCE

The maintenance associated with OSG is cleaning the electrolytic cell due to inorganic salt buildup on the cathode surfaces due to calcium and magnesium. Since the solution is generated on site and on demand at a low concentration, there is no concern with degradation or off-gassing. Operators and plant managers state that time invested in OSG maintenance is similar to that required with chlorine gas.

Concentrated liquid chlorine stability is greatly affected by both the absolute concentration and temperature. Bleach degrades fast with increasing temperature and concentration; degradation leads to the formation of chlorate and oxygen gas. A 15% bleach solution stored at 26.6 °C (80 °F) showed a 28% degradation over one month. Facilities using bulk sodium hypochlorite bleach must adjust for degradation over time, dilute their solution upon receipt, plan for more frequent deliveries, or cool the storage room.

Application of concentrated liquid hypochlorite causes a much greater impact to the pH of the treated water, since the pH of the bulk hypochlorite solution is adjusted to a high pH of around 12-13 to reduce degradation during storage. The pH of an on-site generated hypochlorite is only 9, meaning that it is 1,000 to 10,000 times less caustic than using liquid chlorine. OSG can often significantly reduce the use of pH adjustment chemicals.

Concentrated hypochlorite, from liquid or solid solubilized into liquid, is also significantly more corrosive and is more prone to off-gassing chlorine than OSG. The corrosiveness and off-gassing cause subsidiary maintenance requirements to the facility.

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ENVIRONMENTAL IMPACT

OSG significantly reduces the addition of carbon to the environment, due to the reduced amount of material that is transported. The volume of liquid chlorine is nearly five (5) times more than the volume of salt required to generate an equivalent amount of hypochlorite on site.

SAFETY

While it has been stated prior that OSG is safer than the alternate forms of deploying chlorine for disinfection, the only safety concerns with OSG involve hydrogen and electricity, both of which can be controlled through proper system design and installation. With several thousand OSG systems installed in the United States, and even more world-wide, the ease of achieving safe operating conditions is self-evident.

In contrast, bulk chemical chlorine creates an ever-present potential for an accidental chlorine release during transport to the site, transfer to storage tanks, and storage of the chemical. Although the results of an accident with liquid and solid chlorine deployment are usually less severe than with gas chlorine, the occurrence is more frequent, causing disruptions to facility operations and communities.

CONCLUSION

Experience indicates that OSG is a more favorable solution than delivered gas, liquid, and solid chlorine. OSG also has a strong safety record, favorable lifecycle costs, ease of operation and maintenance, and a low carbon footprint.