Sodium Hypochlorite – an Alternative to Chlorine Gas: Considerations & Lessons Learned

Presentation to the South Texas AWWA/WEAT

By: Paul Walker
July 26th, 2013
Agenda

1. Considerations when switching to an alternate disinfection storage and feed system
2. Discussion of alternatives
   a. Dilute on-site sodium hypochlorite generation (OSHG)
   b. High strength OSHG
   c. Bulk sodium hypochlorite
3. Lessons learned
4. Questions
Considerations if switching to an alternate system
Low probability of a major Cl₂ gas leak can be overshadowed by consequences of exposure

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<th>Cl₂ Exposure Concentration</th>
<th>Effects</th>
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<td>Moderate irritation of upper respiratory tract</td>
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OSHG & Bulk Hypo Reduce Risk
Alternatives Reduce Regulatory Requirements

- EPA Risk Management Planning (RPM) not required
  - Exception if using bulk OSHG & storing hydrochloric acid above threshold amount
- Chemical Facility Anti-Terrorism Standards Act (CEFAT) would not apply if water sector exemption ever removed
- Still requires hazardous occupancy classification due to $\text{H}_2$ generation
Alternatives to Cl$_2$ gas are usually more expensive

Austin WTP4 Example (Dec ‘08)
OSHG can reduce supply volatility

HISTORICAL PRICE OF CHLORINE AND PRODUCERS PRICE INDEX TRENDS

Source: US Department of Labor, Bureau of Statistics, provided by Rick Coronado, City of Austin
Sodium Hypochlorite Generation, Storage, & Feed Alternatives
Three alternatives are available when using sodium hypochlorite:

- **Dilute OSHG (<0.8%)**
- **High strength OSHG (12.5%)**
- **Bulk Liquid (10 – 15%)**
Dilute OSHG is fundamentally simple

Salt + Water + Electricity = Sodium Hypochlorite Solution + Hydrogen Gas

NaCl + H₂O +2e = NaOCl + H₂
A dilute OSHG system is a batch process
Materials needed to produce a solution are not insignificant

1.0 lb of chlorine equivalent requires approximately:

- 15 gallons of water
- 2.5 - 3 lbs of salt
- 2.0 kw-hr of power
Brine tanks store salt & produce brine
Brine systems come in a variety of sizes
Softeners are a critical component of the system.
Water chillers improve generation efficiency
The rectifier and generator are the heart of the system
Vertical & horizontal generators are available
Blowers provide continuous venting of hydrogen gas
The low solution strength increases metering requirements
High strength OSHG relies on chlor-alkali process
High strength OSHG is more efficient, but complex
High strength OSHG uses less salt & water than low strength, but more chemicals

1.0 lb of chlorine equivalent requires approximately:

- 1 gallon of water
- 1.8 lbs of salt
- 1.8 kw-hr of power
- .012 gal NaOH (50%)
- .017 gal HCl (37%)
- .007 NaHSO3 (38%)
The rectifiers and electrolyzer modules are heart of the system
Bulk salt storage can be used instead of a briner tank
A turnkey approach is an option for high strength OSHG

- Operation of system is responsibility of manufacturer (ETC)
- End user does not inherit operation of complex technology
- Available for systems that feed a combined capacity of at least 5,000 ppd
- Can include design assistance, installation, and operation
Bulk sodium hypochlorite requires liquid storage & metering
Bulk hypo decomposes & chlorate is one of pathways to decomposition.

Good practice to reduce decomposition includes:
1. Filter solution to remove contaminants
2. Lower storage temperature
3. Reduce concentration
4. Reduce storage time
Off-gassing is an issue when feeding bulk hypochlorite

1. Avoid high spots in piping that can trap off-gas
2. Use diaphragm valves
3. Consider adding de-gassing valves
Lessons Learned
• 4,500 pounds per day capacity
• Can treat 75 mgd in Phase I, expandable to 150 mgd by adding equipment
• Selected PSI equipment after using a base bid/alternate bid approach
• OSHG Building Bid for ≈$6 million (Mar 2011)
WTP 4 OSHG building section

21’
WTP 4 shows magnitude of OSHG storage requirements

- Gas - Ton Cylinders/Bulk
- Bulk Sodium Hypochlorite
- OSGH
Selecting on price + qualifications improves results

![Comparison of Supplier Score](image)
Holly WTP retrofit provides an example of how to convert from Cl$_2$ to bulk hypochlorite

- 210 MGD (North & South Plants)
- Converting from bulk Cl$_2$ in 2 phases:
  - Phase I: Bulk Hypochlorite
  - Phase II: OSHG ahead of bulk storage
- Bid for $2.4 million – June 2011
Existing, unused basins repurposed for hypo system

Existing structure

New hypo storage

New feed equipment area
Lined, concrete tanks offer cost-effective solution storage
Tom Taylor Regional WTP provides example of a dilute OSHG refurbishment

- 70 mgd of capacity
- 6,000 ppd generation capacity
- Pre-selected PSI equipment after evaluating suppliers
- Bid for $\approx 2.1$ million – December 2010
Generator room completely refurbished

Good reminders:
1. Make sure manufacturer is clear on temperature requirements
2. Pay attention to service water pressure
Bulk hypo storage tanks eventually need to be replaced, so plan accordingly.

Tank life can be extended by:
1. Robust tank specifications
2. Annual tank drainage & cleaning
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