

DECIPHERING DISINFECTION

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- Recent supply chain issues have caused service interruptions and increasing costs for water treatment chemicals
- This has led many utilities to search for alternative sources of disinfection
- This presentation aims to go over three disinfection sources in attempt to help you determine what source is the best for your utility
- The three disinfection sources include:
 - Chlorine gas,
 - Bulk sodium hypochlorite,
 - On-site sodium hypochlorite generation

- Background
- Efficiency
- Safety
- Maintenance
- Reliability
- Footprint
- Costs
- Design Considerations



BACKGROUND

Chlorine Gas

- Most common disinfectant in the 20th century
- Seen as a simple, cost-effective source of disinfection
- Generally shipped to treatment plants by trucks (cylinders) or railcar



Bulk Sodium Hypochlorite

- Safer alternative to chlorine gas
- Commercially available as 12.5% trade strength
- Most popular method
- Delivered in tanker trucks



On-Site Generated Sodium Hypochlorite (OSHG)

- Removes hazardous material shipping
- 3 ingredients: salt, softened water, and electricity
- Lower strength (0.8% vs. 12.5%)



EFFICIENCY

Chlorine Gas

- Very efficient disinfectant
- 100% chlorine strength – lowest volume usage
- Very stable – no strength loss
- Some pathogen resistance to low doses
- Can lead to DBP formation (HAA5)



Bulk Hypochlorite

- Moderately strong disinfectant – 12.5% chlorine strength
- Loses strength over time
- Leads to DBP formation (THMs)



OSHG

- Lowest strength disinfectant – 0.8% chlorine strength
- Very stable – won't lose strength
- Similar DBP formation to bulk hypo



SAFETY

Chlorine Gas

- Respiratory problems
- Chlorine gas in water – Hydrochloric acid
- More paperwork - Risk Management Plan and Process Hazard Analysis





Bulk Hypochlorite

- Safer alternative compared to gas
- Stronger than store-bought bleach
- Flush lines if not frequently used
- Avoid total pipe isolation



OSHG

- Safest disinfectant – 0.8% strength
- Prevent hydrogen gas build-up
- Manufacturer safety systems
- Safety requirements similar to bulk hypo



MAINTENANCE

Chlorine Gas

- Preventing leaks is main goal
- Replace header valve packings yearly
- “Screech Test” on flexible connections
- Clean system after 250 tons
- Difficult to fix pipes



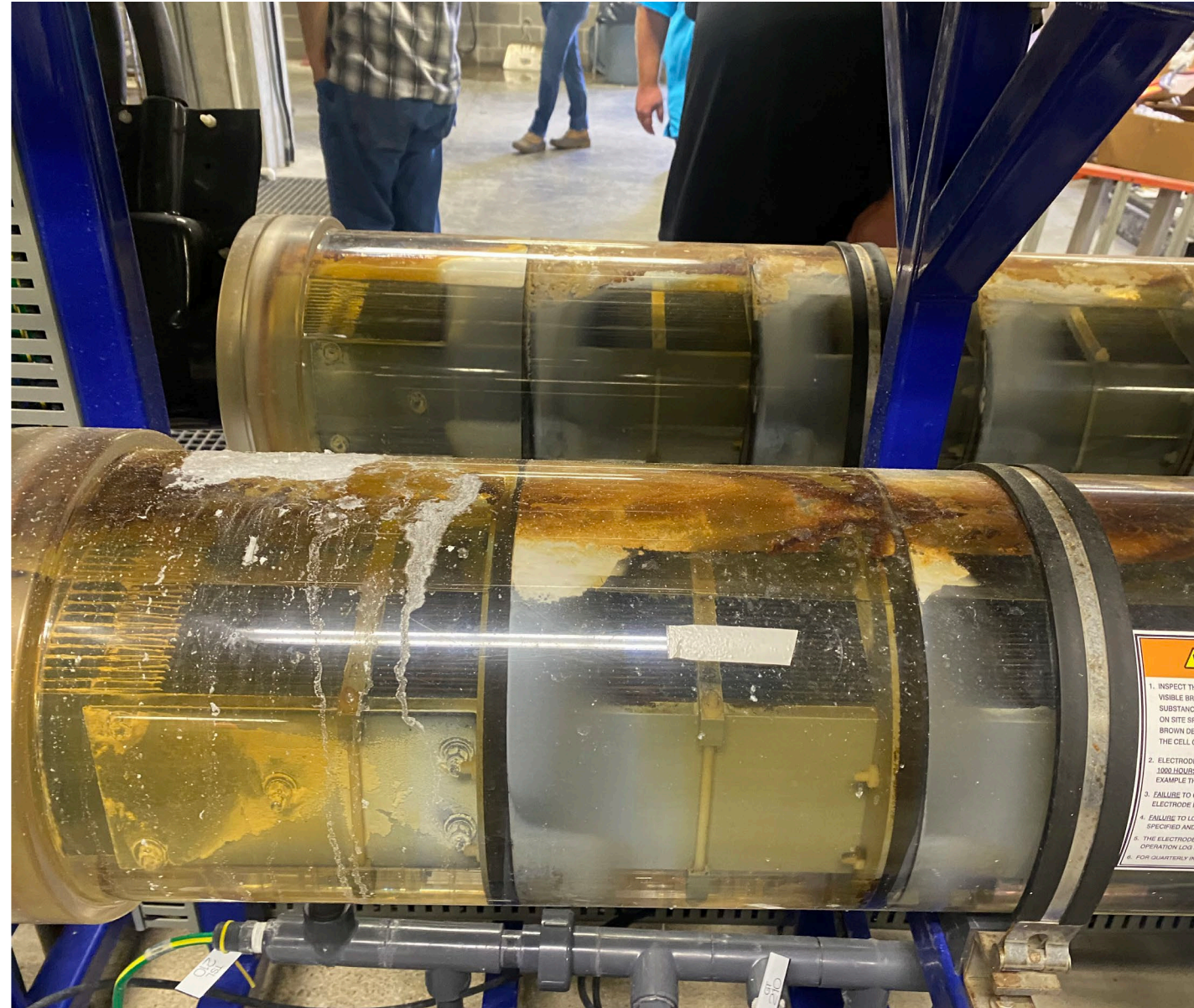
Bulk Hypochlorite

- Leak prevention #1 concern
- Yearly tank inspections recommended
- Routine maintenance on pumps
- Easy system to maintain



OSHG

- More components = **More maintenance**
- Acid washing required
- Generator cell replacement – Manufacturer specific
- Brine is corrosive to sensors



RELIABILITY

Chlorine Gas

- Tried and tested
- Hazardous material shipment
- Can only draw so much from cylinders without evaporator
- When something goes wrong, it really goes wrong



Bulk Hypochlorite

- Fewer failure points
- Hazardous material shipments
- Hypo strength degrades over time
- Multiple tanks and pumps = resiliency



OSHG

- No loss in strength
- Acid wash regularly
- Use high quality salt
- Salt is easier to get and store
- Follow manufacturer's recommendations
- Bulk hypochlorite backup



FOOTPRINT

Chlorine Gas

- Separate buildings required for storage and chlorinators
- Footprint depends on storage capacity
- Consider overhead room and floor space
- Outside space may be needed for scrubbers



Bulk Hypochlorite

- Tank farm takes up most space
- 30-day chemical storage recommendation (max)
- Find balance for hypochlorite storage
- Building for dosing pumps needed



OSHG

- Largest footprint requirement
- Similar requirements to bulk hypochlorite
- Check ceiling height
- Confirm indoor/outdoor placement



COSTS

- Costs for all disinfection systems will depend on your treatment plants unique needs and requirements
- The type of system and manufacturer chosen, existing spaces that can be retrofitted, and unforeseen issues can alter costs
- The following costs were created for a 10 MGD treatment plant with a total chlorine dose of 5 mg/L
- In addition, an assumption was made that a building to fit the system was already available

Chlorine Gas

- Costs depend on shipping size
- Chlorine delivery is the major recurring cost for chlorine gas systems
- Current cost = \$1.18 per pound



Chlorine Gas – 20-year Life Cycle Cost Analysis

Parameter	Cost (\$)
Capital Cost	\$3,885,000
Annual O&M Costs	\$340,000
Annual Chlorine Delivery Costs (1-ton)	\$180,000
20-Year Net Present Worth	\$12,000,000

Bulk Hypochlorite

- System with fewest components
- Storage tank cost = \$3.50 to \$5 per gallon
- Current delivery costs = \$3 per gallon



Bulk Hypochlorite – 20-year Life Cycle Cost Analysis

Parameter	Cost (\$)
Capital Cost	\$136,000
Annual O&M Costs	\$84,000
Annual Hypo Delivery Costs	\$361,000
20-Year Net Present Worth	\$5,850,000

OSHG

- Generator costs vary, but are similar
- Bulk hypo systems + more
- Salt costs = \$0.19 per pound
- Electricity costs can add up



OSHG – 20-year Life Cycle Cost Analysis

Parameter	Cost (\$)
Capital Cost	\$1,400,000
Annual Electricity Costs	\$38,000
Annual Salt Delivery Costs	\$88,000
Annual O&M Costs	\$19,000
20-Year Net Present Worth	\$7,910,000

20-year Life Cycle Costs Analysis Comparison

Disinfection Source	20-Year Present Worth
Chlorine Gas	\$12,000,000
Bulk Sodium Hypochlorite	\$5,850,000
On-Site Generated Sodium Hypochlorite	\$7,910,000

DESIGN CONSIDERATIONS

Chlorine Gas

- #1 Priority = Safety of Operators
- Use Schedule 80 seamless steel piping
- Automatic switchovers are highly recommended
- Material compatibility is key
- Chlorine scrubbers are a necessity

Bulk Hypochlorite

- Primarily use PVC
- **Vented ball valves**
- Storage Tanks – FRP or XLPE
- **Non-fumed silica solvent cement**
- Ensure chemical compatibility
- Flexible connections on tanks
- Peristaltic pumps recommended
- Heat tracing recommended

OSHG

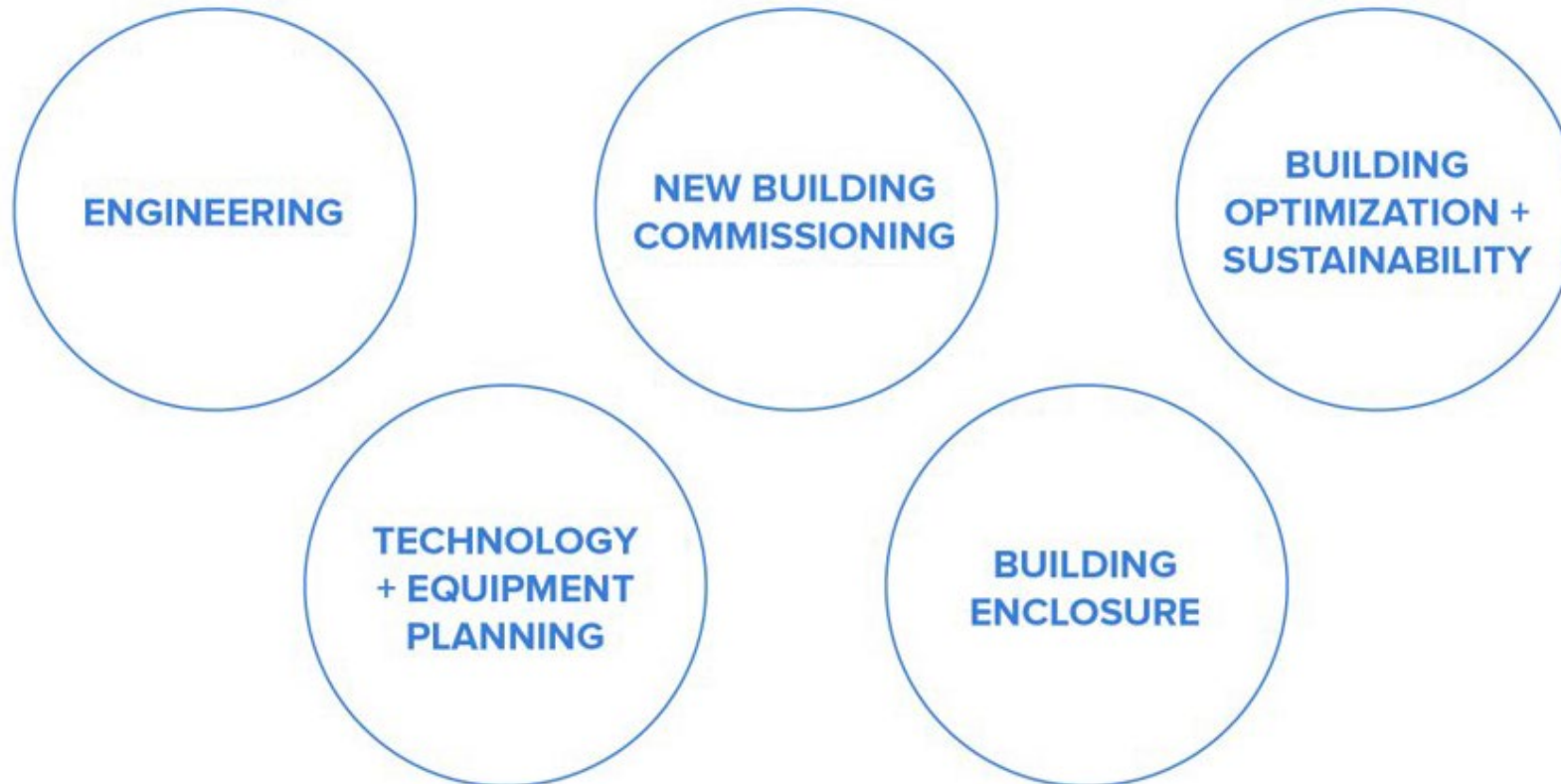
- Generator to tank piping – CPVC
- Very similar to bulk hypochlorite
- Ensure proper hydrogen venting with sensors
- **Use high quality salt**
- Be aware of the OSHG manufacturer's rectifier requirements
- Plan on needing extra space
- Heat tracing required

CONCLUSIONS

Parameter	Chlorine Gas	Bulk Hypochlorite	OSHG
Efficiency	1	2	3
Safety	3	2	1
Maintenance	2	1	3
Reliability	2	1	2
Footprint	2	1	3
Costs	3	1	2

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