Best Practices for Chemical Facility Design in Water Treatment

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Overview

• Introduction
• Design Considerations
  • Storage Tanks
  • Recirculation / Transfer Pumps
  • Metering Pumps
  • Piping and Valves
  • Safety Considerations
• Acknowledgements / Questions
Introduction
Regulations Driving Chemical Application

• Federal Safe Drinking Water Act (SDWA)
  o Driver for new and advanced treatment technologies
  o Chemical systems play major roles in water treatment
  o Drinking Water Rules
    ▪ Surface Water Treatment Rule
    ▪ Disinfectant / Disinfection Byproducts Rule
    ▪ Long Term Enhanced Surface Water Treatment Rule
    ▪ Ground Water Rule
    ▪ Total Coliform Rule
    ▪ Lead and Copper Rule
    ▪ Arsenic Rule
Processes and Associated Chemicals

Pretreatment
- Taste and Odor
  - Ozone
  - Powdered Activated Carbon
- Oxidation
  - Potassium Permanganate
  - Sodium Permanganate
  - Chlorine

Coagulation / Flocculation / Sedimentation
- Aluminum salts (aluminum sulfate)
- Ferric salts (ferric chloride, ferric sulfate)
- Polyaluminum chloride (PACl)
- Polymers (coagulant-aid)
- Polymers (flocculation-aid)
- Chemicals for pH adjustment

Filtration
- Chlorine
- Polymer (filtration-aid)
- pH adjustment

Disinfection
- Chlorine
- Ammonia and base (lime or sodium hydroxide for chloramination)

Distribution
- Fluoridation
- Corrosion Inhibition
- Base for pH adjustment
Design Guidelines

- Building Code (containment, sprinklers)
- NC Admin. Code Title 15A, Subchapter 18C
- 10-State Standards
- OSHA
  - Confined spaces
  - Ladders for tanks
  - Tempered water for emergency showers
- NSF 60 – Drinking Water Treatment Chemicals
- NSF 61 – Drinking Water System Components
Design Considerations
Storage Tanks
Materials

- Fiber-reinforced plastic (FRP)
- High-density polyethylene (HDPE)
- Carbon steel, stainless steel
Sizing

• Typically 30-day storage for most chemicals (15-day for hypochlorite)
• Assess historical flows and doses
• Consider location of supplier, delivery volume, and dilution volume needs
• Day tanks:
  o 24 hours or once per shift
  o Can add a 25% safety factor
Accessories

- HDPE: flexible connections, molded fittings
- FRP: Handrail
- Steel: Handrail, relief valve (if pressurized)
- Manways, level instruments
- Overflow
- Heat tracing / insulation
- Mixing equipment
- Weigh scale

Poly Processing
Containment

• Exterior: Largest tank + stormwater
  o 24 hour storm during a 25-year storm event
  o Rainfall data: NOAA Precipitation Frequency Data Server

• Interior: Largest tank + sprinkler water
  o Sprinkler rate per square foot for 20 minutes

• Tie-downs

• Chemical-resistant liner

• Sumps and chemical-resistant sump pumps
Key Considerations
Don’t Tank Your Design

- Chemical calculations
- Chemicals that degrade
- “Nominal” volume of tank
- > 12-foot diameter tanks
- Installation / removal of tanks
- Containment calculations
- Sufficient volume for delivery + remaining
- Adequate sizing for outlets / manways
- HDPE molded outlets / manways
Recirculation / Transfer Pumps
Purposes

1. Mix diluted chemicals
2. Transfer from bulk to day tanks
3. Transfer between bulk tanks

Different design criteria for each
(static head, dynamic headloss, flowrate)
Type and Sizing

- Magnetic drive centrifugal
- Positive displacement / gear – high viscosity
- Recirculation time
- Transfer time:
  - Two minutes for smaller tanks
  - Varies for larger tanks
Key Considerations
Pump Up Your Design

• Specific gravity and viscosity of chemical
• Chemical compatibility
• Temperature rating
• Control capabilities
• Suction lift capabilities

Cationic Polymer (EXAMPLE)

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<tr>
<td>Product Form</td>
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<td>Product Feed Method</td>
<td>Metering Pumps</td>
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<td>Specific Gravity</td>
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<td>Chemical Strength, %</td>
<td>100%</td>
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<td>Effective Density, lb/gal</td>
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<td>Viscosity, cps</td>
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Metering Pumps
Types

- Mechanically actuated diaphragm
- Hydraulically actuated diaphragm
- Peristaltic
- Solenoid
Sizing

- **Range of pump:**
  - Maximum plant flow and maximum chemical dose
  - Minimum plant flow and minimum chemical dose
- **Multiple pumps may be required for one point**

### Technical Specifications

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### Performance Curve

- [Graph showing performance curve]

Grundfos

Verderflex
Accessories

- Back pressure valves
- Anti-siphon valves
- Pressure relief valves
- Pressure gauges
- Calibration columns
- Pulsation dampeners
Key Considerations
Pump Up Your Design

• Chemical compatibility
• Accounting for chemical properties for diaphragm pumps
• Overall hydraulic calculations
• Accuracy at low turndown
• Space for panels
Piping and Valves
Pipeline and Valve Materials

- Most chemicals utilize PVC and CPVC
- CPVC has higher heat and UV resistance
- Specify pipe-related elastomers and solvent cement with chemical compatibility
- Others, depending on chemical and scenario
Common Valves for Chemicals

- **Ball valves**
  - Vented for off-gassing chemicals
- **Ball check valves**
- **Diaphragm valves**
  - For chemicals that crystallize, off-gas, have particles, or are viscous
- **Needle valves**
Accessories

- Carrier water
- Pressure gauges
- Flushing connections
- Magnetic flow meters
- Flow indicators / switches
- Y strainers
- Unions
- Anti-siphon / back pressure valves
Pipeline Routing

• Interior
  o Double containment outside of contained chemical room

• Exterior
  o Ductbanks
    ▪ Casing / carrier pipe system
    ▪ Potential for backup carrier pipes
  o Trenches
  o Direct bury
  o Above grade
Chemical Application and Mixing

- Chemical injectors
- Static mixers
- In-line mechanical mixers
- Chemical pipeline diffusers
Key Considerations
Not Just a Pipe Dream

- Potential softening of carrier water
- Diaphragm seals on gauges
- Bypass for strainers
- Long radius bends of casing pipe
- Penetrations of pipes through containment
- Adequate mixing
Safety Considerations
Key Considerations

A Safety Net

- Tempered water for showers / eyewashes
- Access to exits, showers / eyewashes
- Access to sump pumps
- Personal protective equipment
- Cages for ladders
- Specific chemical requirements
Conclusions
Chemical Facility Design

• Every design is unique
• Design considerations related to code and safety should always be incorporated
• Follow up on past designs and talk to other municipalities to learn what works and doesn’t work
Acknowledgements

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Questions?

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