Storage & Associated Equipment
Corrosive Liquids

Product Stewardship / Outreach Information

Presentation Overview

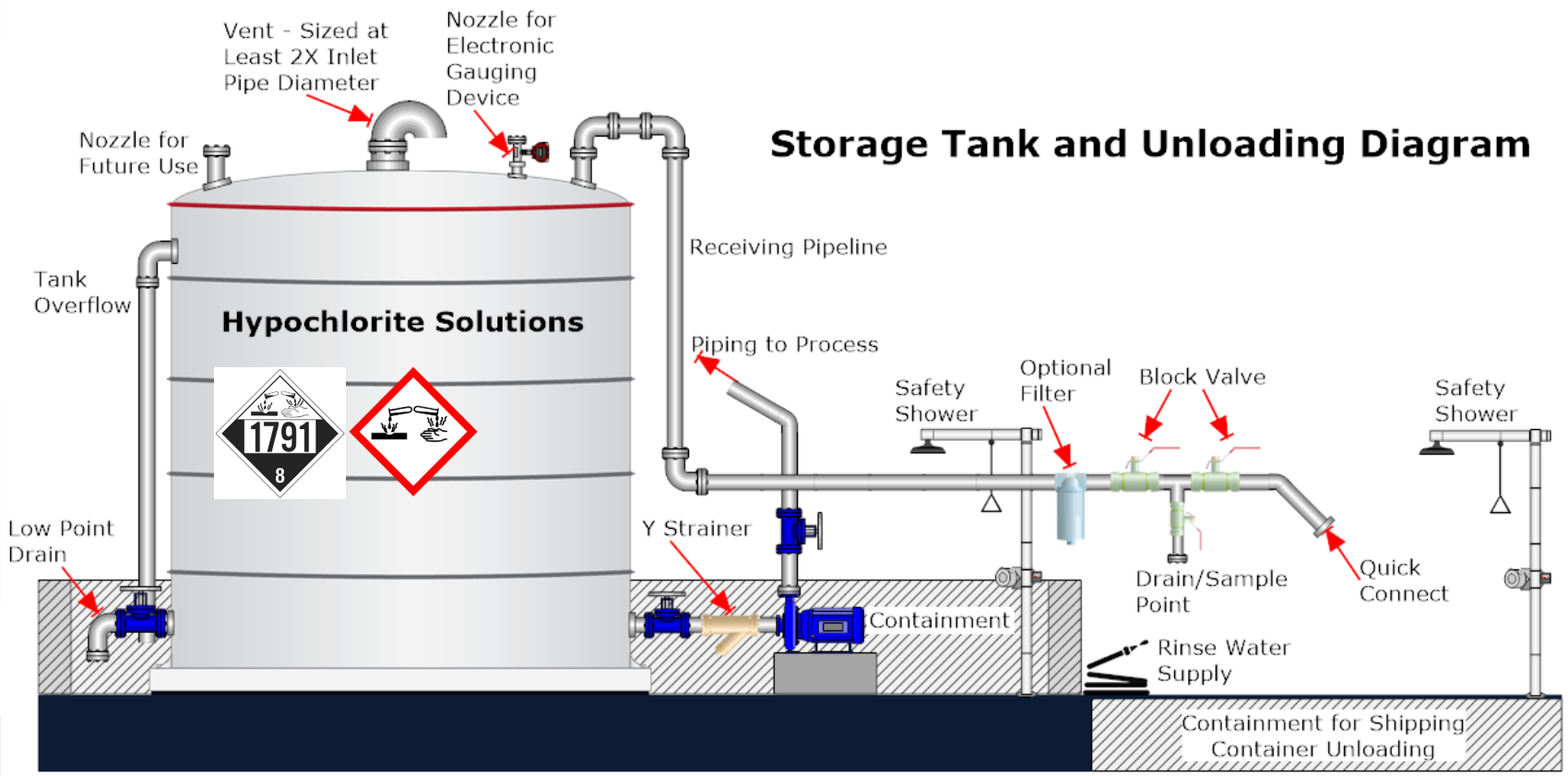
- Storage Tanks
  - Hypochlorite
  - Hydroxides
  - Hydrochloric Acid
- Piping
  - Hypochlorite
  - Hydroxides
  - Hydrochloric Acid
- Level Transmitters
- Pumps
- Valves
- Scrubber – Hydrochloric Acid

Storage Tanks

Storage & Piping

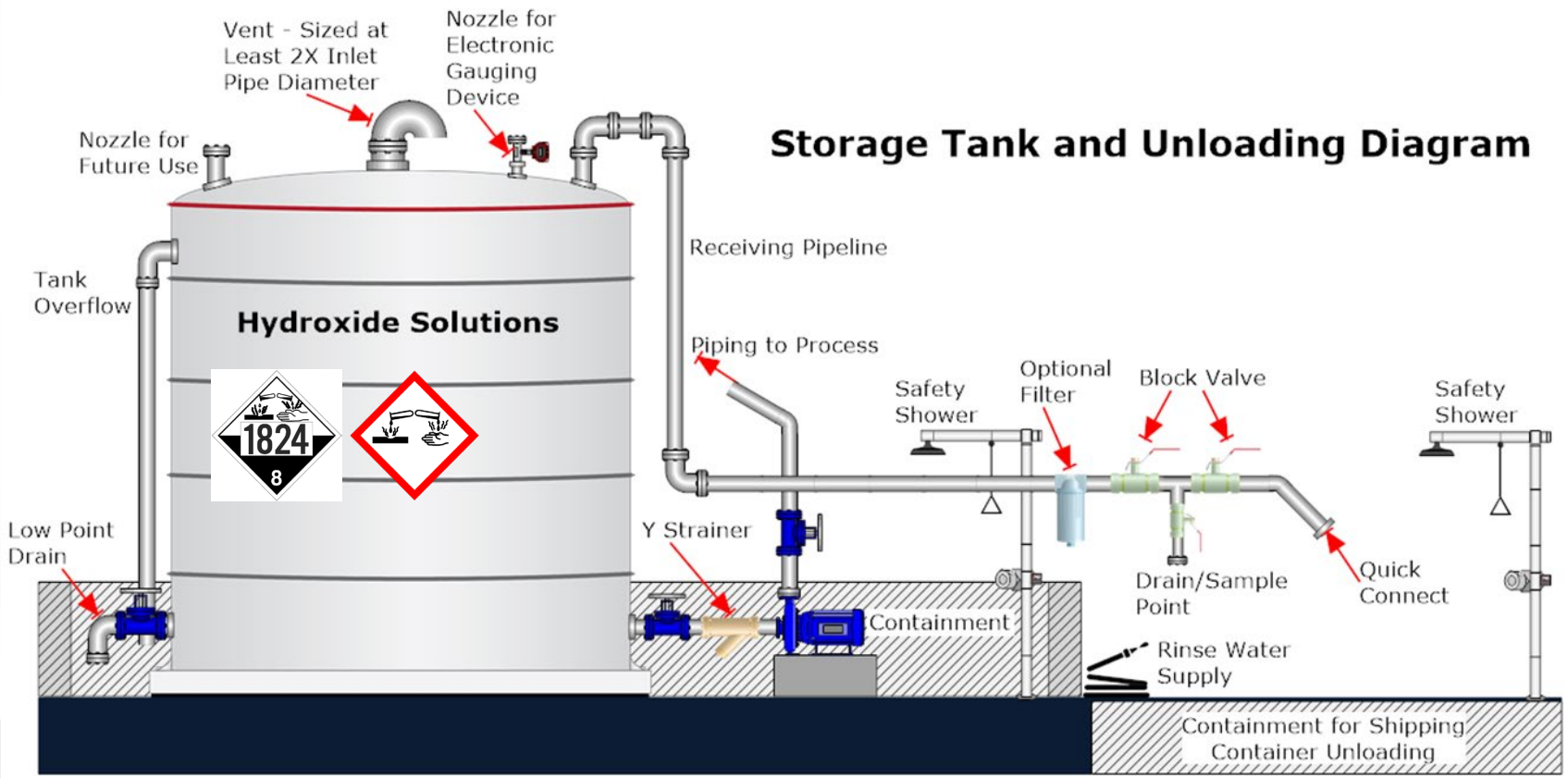
Storage Tanks & Unloading Sketch

Sodium Hypochlorite



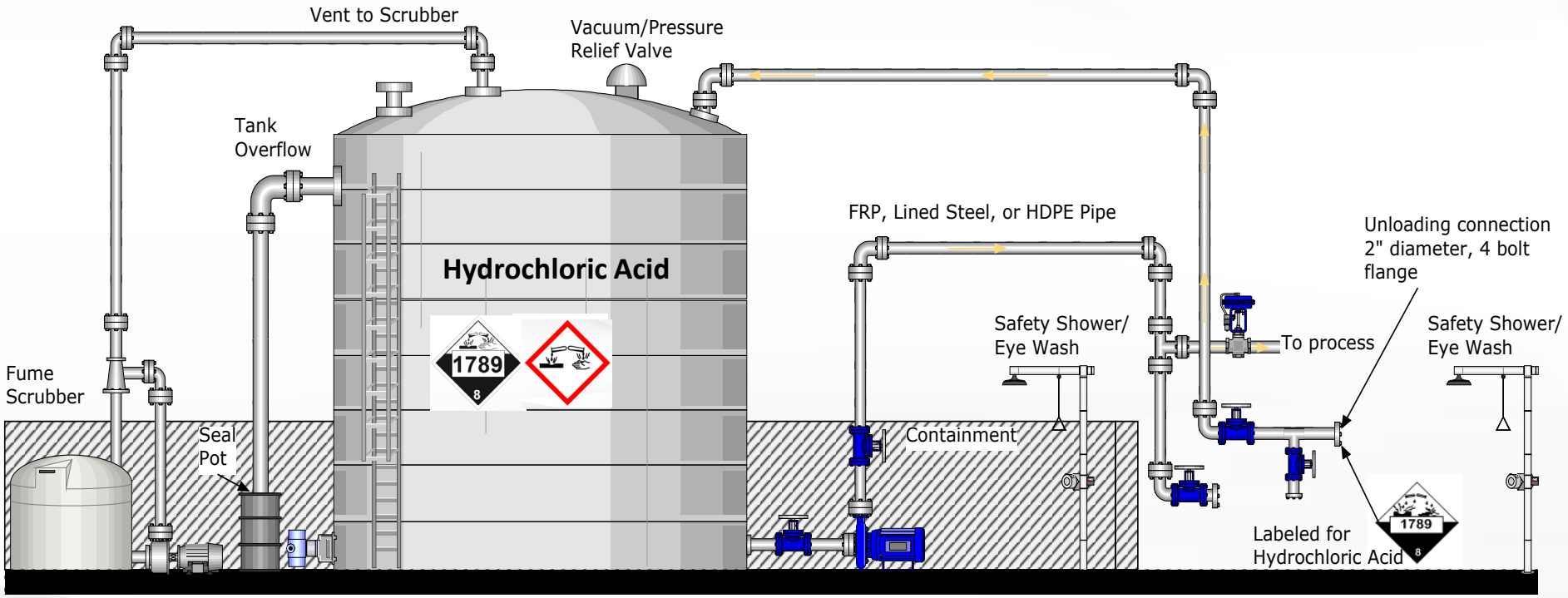
Storage Tanks & Unloading Sketch

Sodium Hydroxide



Storage Tanks & Unloading Sketch

Hydrochloric Acid



Storage Tanks

Design/Function

- Consult with manufacturer/discuss:
  - Operational considerations.
  - Tank fill process (Air vs pump)
  - Draining and Cleaning
- Capacity should be 1.5x the largest delivery volume

Storage Tanks

Design/Function (continued)

- Vent – size based on Mtl. of Const.
  - Non-metallic tanks – minimum 2x the inlet pipe diameter.
  - Vent should NOT act as both vent and overflow.
- Overflow - should be at least 1.5x the inlet pipe diameter.
  - Side wall installation.
  - Typically installed to relieve at 90% of tank's volume.
  - Should direct, (not splash), chemical into containment.

Storage Tanks

Tank Mtls of Construction

Steel

- For Hydroxide solutions ONLY. NOT for use with sodium hypochlorite or hydrochloric acid.
- Carbon Steel
  - Hydroxide temperatures < 140° F.
  - Some potential for iron contamination
  - May require passivation.
- Stainless Steel (More Expensive)
  - Hydroxide temperatures < 170° F
  - Long life, Least iron contamination.

Storage Tanks

Tank Mtls of Construction

Lined Steel

- Often used for large storage tanks.
- Requires regular inspection. (Conductivity or spark tests often used.)
- Liner selection affected by the chemical stored, concentration, temperature, and fluid velocity (agitation, nozzle flow-rate).
- Not often used for sodium hypochlorite but frequently used for hydrochloric acid and hydroxide solutions.
- In most circumstances:
  - Rubber liners are used for HCl
  - Plasite (or epoxy) for hydroxides.

Olin®

Storage Tanks

Tank Mtls of Construction

FRP (Fiberglass Reinforced Plastic)

- 20 years life is typical.
  - Tank fabricator experience is critical.
  - Correct resin and cure system required.
- Mechanical failure via:
  - Excessive pressure/vacuum during operation.
  - External puncture.
  - External ultraviolet (UV)-damage
    (Can be mitigated with coatings)

Storage Tanks

Tank Mtls of Construction

Plastics -
XLPE, HDPE, PP

- Always use a reputable supplier
- Usually limited to <15,000 gal
- Lower cost.
- Lifetime highly variable.
  - Generally shorter than other materials.
- More prone to mechanical damages:
  - Overpressure/vacuum operation.
  - External puncture.
  - UV-damage.
  - Must be installed and plumbed properly to avoid premature damage.

Storage Tanks

Tank Mtls of Construction should be selected based on:

- Risk Analysis
  - Personnel (resources), environmental, equipment, community, etc.
- Cost Analysis
  - Installation, maintenance, replacement cycle, reliability, etc.
- The chemical that is being stored.
- Chemical concentration (specific gravity, etc.)
- Duration of storage
- Temperature (ambient temp and storage temp.)

Storage Tanks

Mechanical failure issues

Improper design/construction:

- Undersized tank vent—should be at least twice the size of the inlet.
- No pressure & vacuum relief device. (Especially HCl)
- Lack of adequate pipeline support (pipe sags).
- Lack of a scheduled component replacement cycle.
- Inadequate support for delivery hose/receiving connector area.
- Tank discharge piping not properly supported, especially for non-metallic tanks.
- Flexible connections are required on plastic tanks!!

Storage Tanks

Mechanical failure issues

- Use/installation of **improper** materials of construction.
  - Exposed incompatible metals
  - Uncoated bolts.
- Failures of lining materials caused by:
  - Excessive heat, i.e. welding.
  - Excessive torque on flanges.
  - Poor installation techniques.

CARBON STEEL AFTER 12 HOURS

Storage Tanks

Mechanical failure issues

Improper practices & procedures:

- Addition of water to acid or hydroxides during dilution.
- Use of sharp metal objects for gauging lined tanks.
- Over-pressurization of the tank.
  - Excess pad gas during unloading.
  - Poorly maintained scrubber system resulting in excess tank pressure or external corrosion (hydrochloric acid)

Storage Tanks

Mechanical failure issues

Lack of mechanical inspections:

- No inspection or too infrequent.
- Inadequate detail/attention when inspecting.
- Lack of a documented inspection checklist.
- Lack of spark testing (lined tanks).

Lack of a scheduled component replacement cycle:

- Non-metallic components don’t last forever!
- Assign a scheduled replacement cycle.
  - Equipment vendors can assist with lifecycle planning.

Storage Tanks

Secondary Containment

- Inspect/repair cracked containment or open expansion joints.
  - Apply alkali/acid-resistant surface coating to containment.
  - Expedite residue removal process.
    - Implement frequent inspections for residue presence.
    - Provide rinse water hose for cleanup.
- Have system in place to test (standing liquids) before discharge.

Storage Tanks

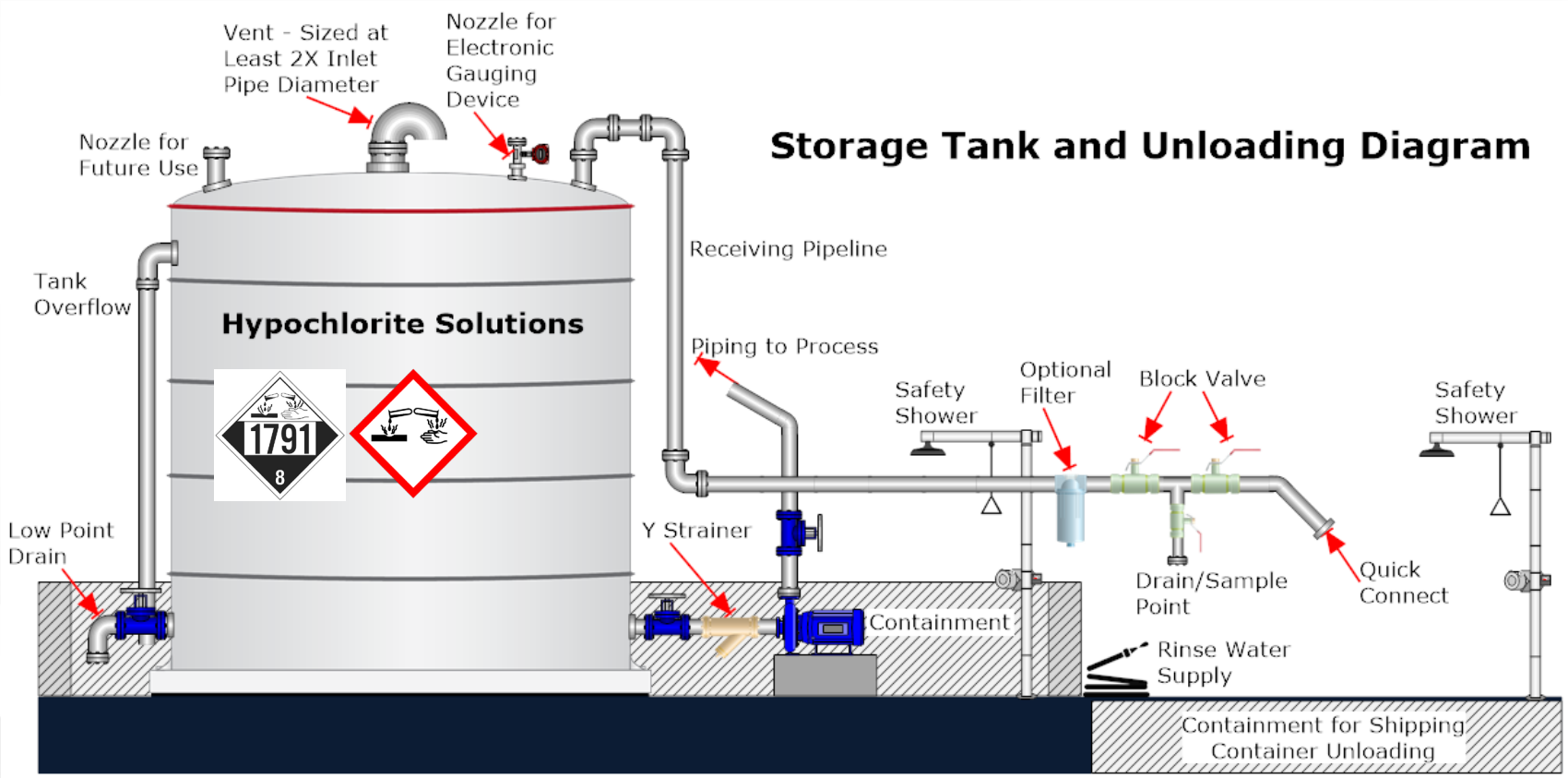
Secondary Containment

Mechanical failure issues:

- Corrosive liquids aggressively attack concrete (and metals).
- Apply industrial grade chemical-resistant coatings to containment.
- Clean up spills quickly.
- Use Teflon® coated bolts for pump bases and other containment-located bolts.
  - Reduces potential for rusted bolts.

Storage Tanks & Unloading Sketch

Sodium Hypochlorite



Storage Tanks

Sodium Hypochlorite

Tank Mtls of Construction

- **Plastic** (Least Expensive)
  - Most Popular
  - HDPE and XLPE
  - PP is NOT recommended for hypochlorite

- **Fiberglass (FRP)**
  - Longer lasting if maintained properly.
  - More expensive than PE.
  - Larger capacities than PPE available.

Olin®

Storage Tanks

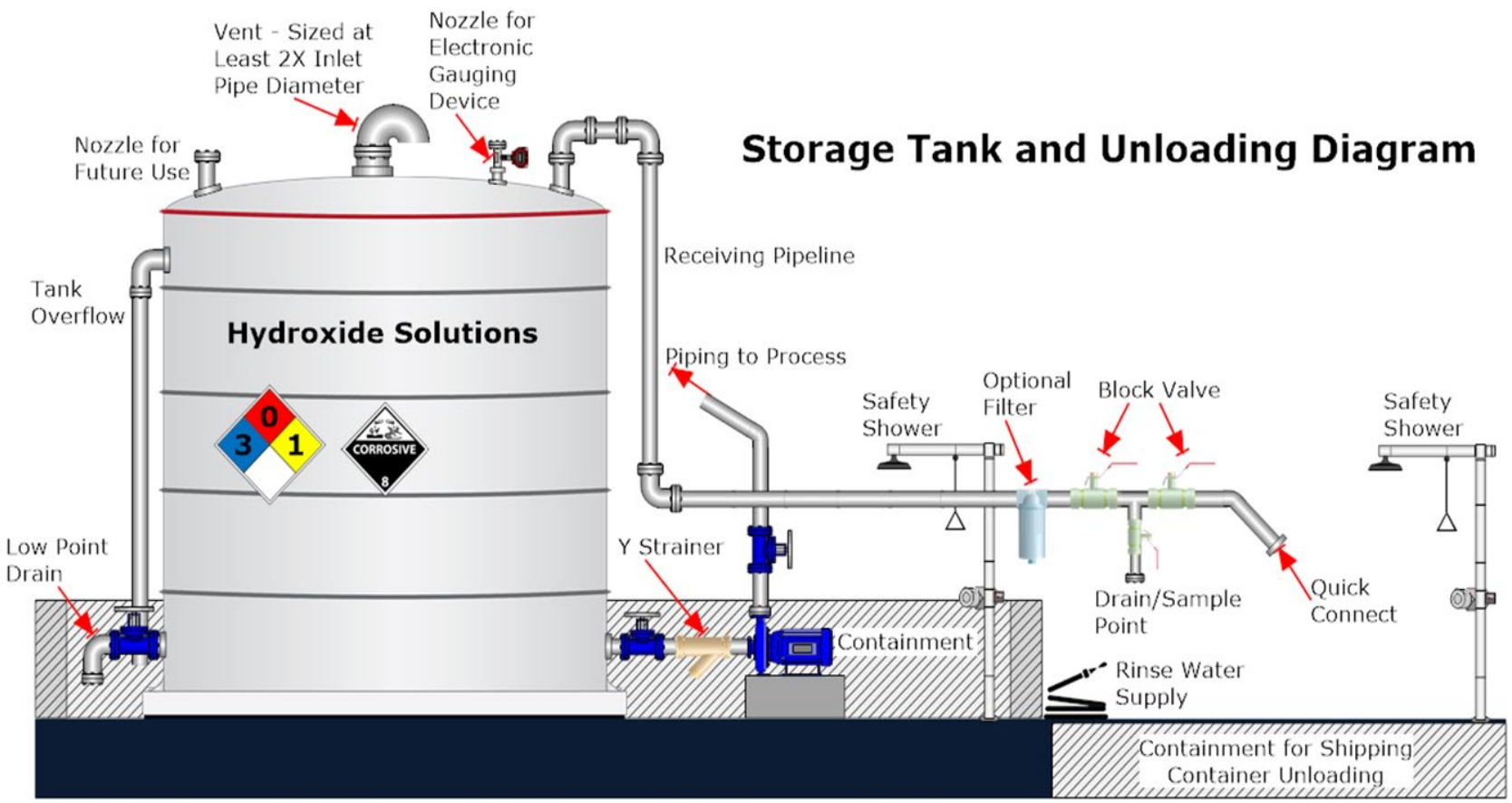
Sodium Hypochlorite

Design/Function
Sodium Hypochlorite

- Consult with manufacturer/discuss:
  - Operational considerations.
  - Tank fill process (Air vs pump)
  - Draining and Cleaning
- Capacity should be 1.5x the largest delivery volume
- Consider radiant energy gain.
  - Under roof, indoors, OUT OF DIRECT SUNLIGHT, or insulate

Storage Tanks & Unloading Sketch

Hydroxide Solutions



Storage Tanks

Hydroxide Solutions

Tank Mtls of Construction

- **Carbon Steel**
- **Lined Carbon Steel** (Ideal)
- **Stainless Steel** (Expensive but very good)
- **Fiberglass (FRP)** (Temperature sensitive)
- **Polyethylene or Polypropylene** (Least Expensive)

Storage Tanks

Hydroxide Solutions

Design/Function - Hydroxide Solutions

- Consult with manufacturer/discuss:
  - Operational considerations.
  - Tank fill process (Air vs pump)
  - Draining and Cleaning
- Tank Capacity should be 1.5x the largest delivery volume
- Consider insulation and heating needs – may be required depending on region and concentration stored.

Storage Tanks

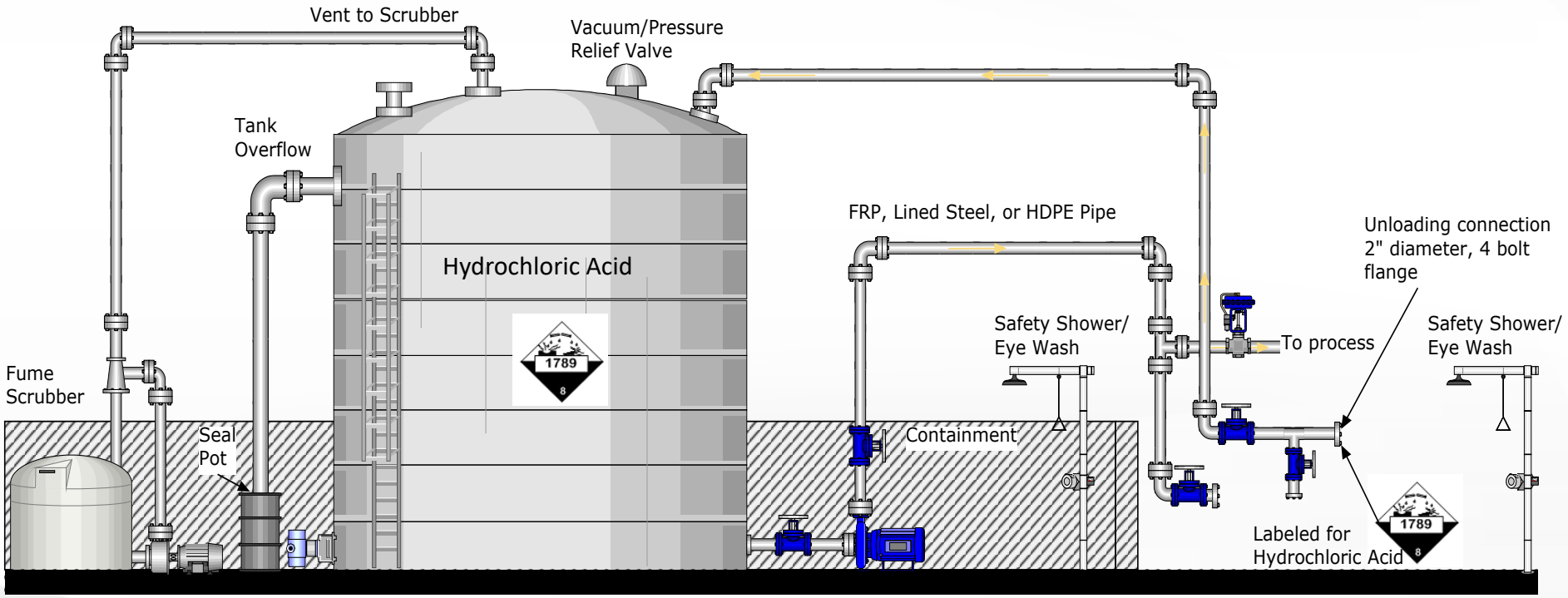
Hydroxide Solutions

Design/Function - Hydroxide Solutions
(continued)

- Vents - sized based on Mtl. of Const.
  - Non-metallic tanks – minimum 2x the inlet pipe diameter.
  - Vent should NOT act as both vent and overflow.
- Overflow - should be at least 1.5x the inlet pipe diameter.
  - Side wall installation.
  - Should direct, not splash chemical into containment.
  - 90% of tank's volume.
- **Inspect vent and overflow piping for alkali residue build-up.**

Storage Tanks & Unloading Sketch

Hydrochloric Acid



Storage Tanks

Hydrochloric Acid

Tank Mtls of Construction

- Lined Steel
- Fiberglass (FRP)
- Polyethylene

Storage Tanks

Hydrochloric Acid

Storage tank design guidelines

- Tank Capacity
  - At least 1.5 times greater than largest incoming delivery.
- Vents
  - At least 2x the diameter of the inlet piping.
  - Shall be installed in such a manner that scrubber can handle vapors.
- Overflow piping must have vapor trap.
- PVRD – Pressure & Vacuum Relief
  - Relieves excess pressure or vacuum to prevent tank collapse.

Storage Tanks

Hydrochloric Acid

Consequences of handling HCl improperly

Explosion Issues:

- HCl, by itself, is NOT combustible or explosive.
- Prolonged contact with metals can generate enough hydrogen to support combustion.
  - Properly vent storage tanks.
  - Thoroughly inspect tanks, pipe, and equipment after maintenance activities for metal.
  - Lining integrity should be checked periodically.

Piping

Storage & Piping

Transfer System - Piping & Fittings

Sodium Hypochlorite

Piping Design

- Made of robust materials.
  - Consider Lined Steel, Pureflex® Durcor®, vs Plastic.
  - Plastic piping must be supported properly
- Support
  - Supported to prevent sag.
- Adhere to manufacturing guidance.
  - Specialized glue used for installation.
- Consider operating conditions:
  - Max. and min. ambient temps.
  - Product temps.
  - Mechanical hammer.

Transfer System - Piping & Fittings

Sodium Hypochlorite

Installation

- Avoid use of threaded pipe.
  - High potential for leakage.
    - Typically used for small diameter piping.
- Securement
  - Understand clamping requirements.
    - Gouging avoidance.
    - Lateral movement needs.
  - Provide adequate support.
- Protect from foot/equipment contact.
- Avoid sunlight exposure when possible.

Transfer System - Piping & Fittings

Sodium Hypochlorite

Scheduled pipe replacement

- Replace non-metallic components prior to failure.
  - Goal-replace component prior to failure using data to arrive at projected replace cycle.
- Scheduled replacement considers:
  - Application.
  - Asset utilization (continuous, daily, monthly).
  - Exposure to the elements.
  - Torque/stresses.
  - Use of compressed air/diaphragm pumps.

Plastic Piping Considerations

- Often viewed as a no-maintenance item, but several factors are at work:
  - Chemical oxidation.
  - Sunlight damage.
  - External torque/stresses.
  - Pipe supports need to be designed to allow expansion / contraction

Transfer System - Piping & Fittings

Sodium Hypochlorite

Incompatible Metals

- Iron (Fe)
  - Carbon Steel
- Nickel (Ni)
  - Stainless Steel/Hastelloy®
- Copper (Cu)
  - Brass and Bronze
- Zinc (Zn)
  - Galvanized
- Chromium (Cr)

Transfer System - Piping & Fittings

Hydroxide Solutions

Piping Design

- Made of robust materials.
  - Steel vs Plastic
  - Plastic piping has same concerns as noted for hypochlorites.
- Consider operating conditions.
  - Heat sources to avoid freezing.
  - Avoid exceeding max temp guidelines.
  - Use of diaphragm pumps / avoiding flow surges with plastic pipe.
  - Include robust pipe support (PVC piping).

Transfer System - Piping & Fittings

Hydroxide Solutions

Piping Design (continued)

- Heating systems or caustic dilution may be required to prevent freezing in winter months.
- Self-regulating electrical heat tape (preferred).
- Steam heating can cause rapid pipe failure from excess heat.
- Consider maximum allowable temperature for piping.
  - Carbon Steel < 140° F (60° C)
  - Stainless Steel (304L, 306L) < 170° F (77° C)
  - Consult vendor for max temperature guidance for plastics.

Transfer System - Piping & Fittings

Hydroxide Solutions

Installation

Adhere to manufacturer guidance

- Avoid use of threaded pipe!
  - High potential for leakage.
  - Typically used for small diameter piping.
- Flanged, butt-welded construction preferred.
  - May need to passivate new carbon piping.
    - Expect high iron & discoloration without passivation.

Transfer System - Piping & Fittings

Hydroxide Solutions

Incompatible Metals

- Aluminum (Al)
- Copper (Cu)
  - (brass & bronze)
- Zinc (Zn)
  - (galvanized material)
- Chromium (Cr)

Transfer System - Piping & Fittings

Hydrochloric Acid

Pipe and accessory materials of construction

- Very corrosive to almost all metals.
- Contact with metals will generate hydrogen gas.
- Use corrosion-resistant materials for wetted service. Examples include:
  - Rubber lining
  - Teflon©
  - Hastelloy© B & C
  - Polypropylene
  - Graphite
  - FRP (Vinyl Ester Resin)
  - Tantalum
  - CPVC

Piping General

Point of Connection Labeling

Piping General
Pipe Identification

- **Labeling—often an oversight!**
  - Include flow direction and content.
    - Position labels for ease of identification.
    - Aids in line-tracing.
- Color-coding systems should be clearly defined and posted.

Level Transmitters

Storage & Piping

Level Transmitters

Critical to prevent overflows

- Types:
  - Ultrasonic
  - Radar
  - Differential Pressure
  - Load cell
  - Reverse Float
- Recalibrate periodically.
- **Avoid unprotected “sight glasses”**

Pumps

Storage & Piping

Pumps

Seal-less Design Pumps

- Magnetically-driven pumps.
- Seal-less pumps are preferred to eliminate the shaft seal as a leak point.
  - Low-amp demand isn't required, but a low-amp cutoff (due to low flow) will protect the pump.
- May fail due to run dry conditions.
  - Designed for continuous flooded applications.
  - Dead-head conditions will ruin a seal-less pump.
- Stainless steel components are typical for hydroxides.
- Lined steels or plastic for hypochlorite/hydrochloric pumps.

Pumps

Centrifugal Pumps

Standard Designs – Mechanical Seals

- Can provide dependable service.
- Presents possible product exposure hazard.
- Shroud / cover seal & shaft area.

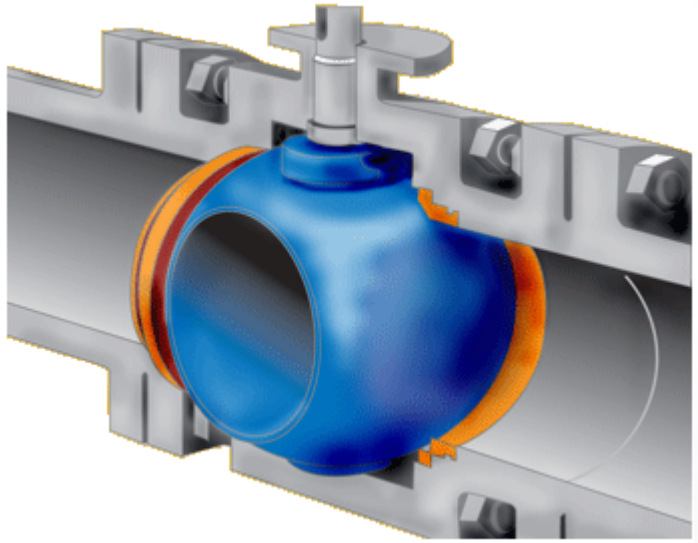
Valves

Storage & Piping

Valves

Ball Valves:

- Ideal for positive, complete flow shut-off applications.
- Construction is typically steel body lined with PFA / PTFE resins.
- Also offered in PVC or CPVC body, ball & handle.
  - Most commonly used for plastic pipe due to lighter weight.
  - Exterior of valve body is also corrosion-resistant.
- Ball Valves for Sodium Hypochlorite should be vented to relieve potential pressure build-up



Valves

Butterfly / wafer-sphere valves:

- These valves are not recommended for use where positive, tight shut off is required. Wear between disk and liner can result in acid leaking through the valve. Examples to avoid include:
  - Tank shut-off valves.
  - Loading/unloading shut-off valves.
  - Tank dike valves.
- Butterfly valves are typically used where flow throttling is required.

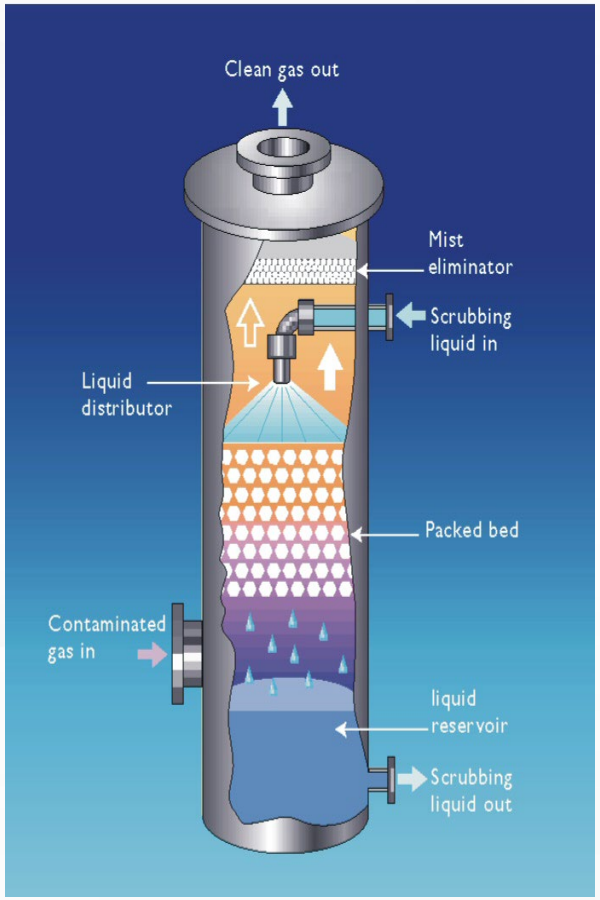
Fume Scrubbers for Hydrochloric Acid

Storage & Piping

Fume Scrubber

Types of Scrubbers

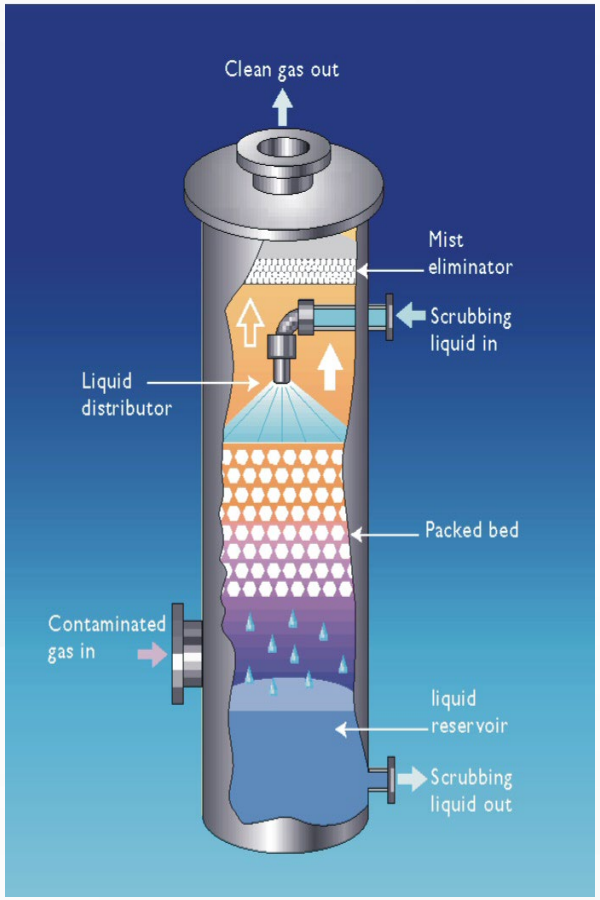
- Several types of scrubbers are available:
  - Recirculating packed column.
  - Spray Tower
  - Eductor or Venturi Scrubber
  - Passive Water or Alkali Scrubber
  - Passive Dry Scrubber



Fume Scrubber

Scrubbing Mediums

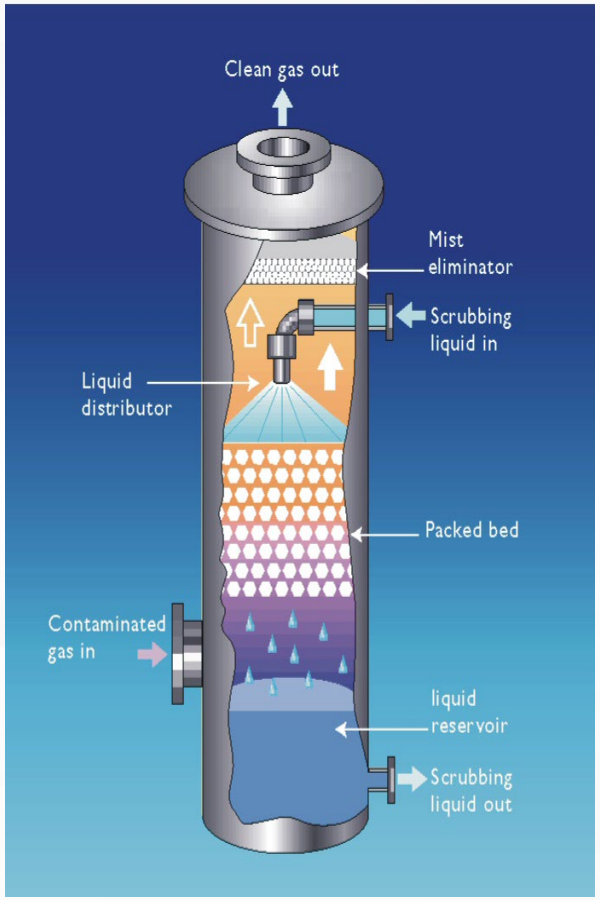
- Several types of scrubbing mediums can be used:
  - Water
  - Alkaline solution
  - Lime rock



Fume Scrubber

Scrubbing Mediums - Water

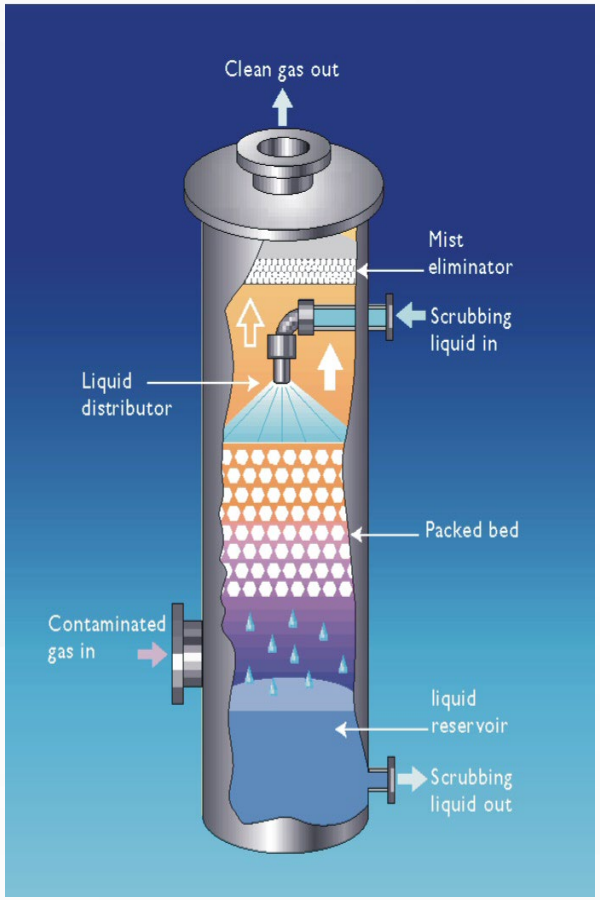
- Packed tower with recirculation loop.
  - Requires recirculating pump and blower
- Eductor-type scrubber with recirculation.
  - Requires a recirculation pump.
- Both offer high efficiency.
- Solution can freeze in colder climates.
- Most common scrubbing medium for HCl
  - Water cost is minimal.
  - Scrubber solution can be re-used.
  - No waste/lost value.



Fume Scrubber

Scrubbing Mediums - Alkaline Solution

- Typically lined steel construction.
  - Must be compatible with elevated temperatures & wide pH ranges.
  - Preferred for high-volume gas loads.
- Use diluted alkaline solution to neutralize HCl vapors:
  - Caustic Soda (more common).
  - Sodium carbonate, lime, other alkalis.

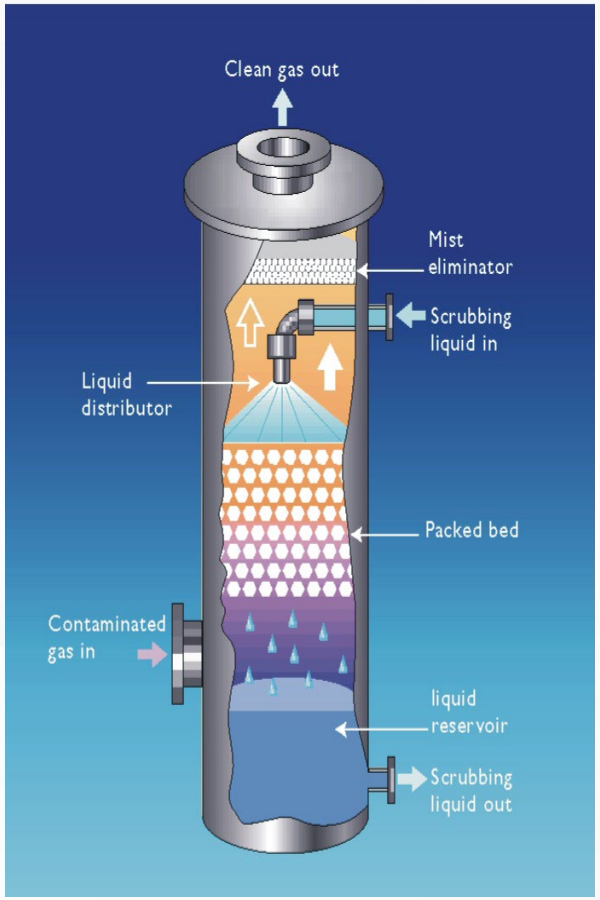


Fume Scrubber

Scrubbing Mediums - Alkaline Solution

Other considerations:

- Generates heat & solids.
- Must use diluted alkali.
  - Reduce solids pluggage and heat.
  - Minimizes solution freeze potential.
- Must monitor sparger for pluggage (back-pressure on tank or process).
- Neutralized material requires proper disposal.



Fume Scrubber

Scrubbing Mediums - Lime Rock (not commonly used)

Passive design:

- Reactor is filled with crushed limestone.
  - Acid vapors react with limestone.
  - Calcium chloride and water generated.
- Low efficiency under high gas loads.
  - Scrubber can be overwhelmed easily.
  - Generally found in low gas flow applications.
- Higher maintenance requirements.
  - Prone to solidification of limestone.
  - Requires slow gas addition for maximum efficiency.

Fume Scrubber

Fume Scrubbers - General

- Should be designed by qualified engineering service.
  - Concept is simple—system balance & efficiency is not!
- Fume removal efficiency must be specified for correct design/operation.
  - Remember to add capacity for truck or RC blowdown if using air to offload.
- Poor design/maintenance can damage the parent tank and/or scrubber tank.
  - Have a written inspection/maintenance plan.
  - Test scrubber solution frequently.
  - Inspect scrubber BEFORE operation.
- Escaping acid fumes will damage surrounding equipment and poses health and environmental concerns.

Websites - Key Resources

- Olin Chlor Alkali Products and Vinyls
  http://www.olinchloralkali.com
- The Chlorine Institute
  http://www.chlorineinstitute.org

For Further Information

OLIN'S TECHNICAL SERVICES
Olin Chlor Alkali Products and Vinyls
490 Stuart Road, NE
Cleveland, TN 37312
Tel: (423) 336-4850 / Fax: (423) 336-4830

THE CHLORINE INSTITUTE
1300 Wilson Boulevard, Suite 525
Arlington, VA 22209
Tel: (703) 894-4140 / Fax:(703) 894-4130
http://www.chlorineinstitute.org