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Sodium Hydroxide Feed System Design and Operation Considerations

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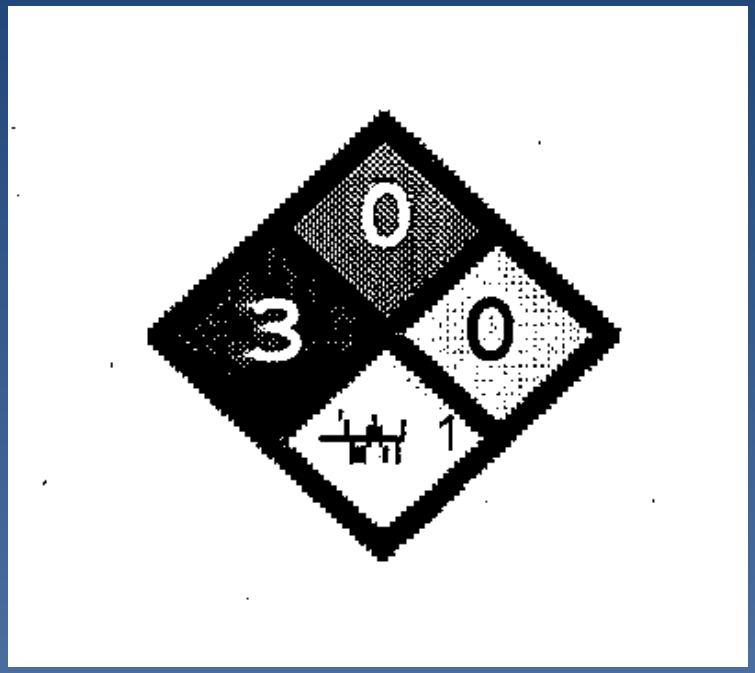
Presentation Outline

- NaOH Properties
- NaOH Delivery and Storage
- Metering Pumps and Piping
- Monitoring and Control
- Safety Considerations
- Startup and Distribution Issues

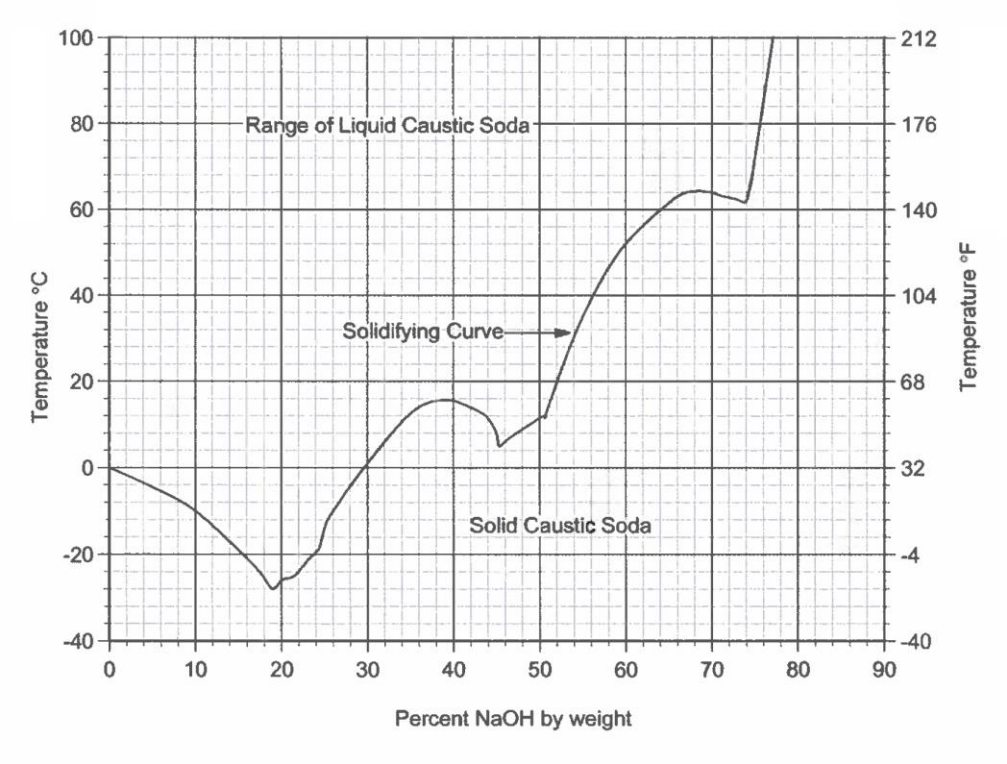
NaOH Properties

- Hazardous Chemical
  - Highly alkaline
  - Chemical burns to eyes and skin
  - Mists – severe irritation to upper respirator tract
- 2009 International Fire Code
  - Health Hazard - Corrosive
  - Physical Hazard - Water Reactive Class 1 (HMEx Assistant)
  - H4 Building Occupancy
    - 500 gallons exempt quantity



NaOH Properties

- Common Concentrations
  - 25% - 2.66 lb NaOH/gal
  - 50% - 6.34 lb NaOH/gal
- Freezing Temperature
  - 25% 7°F
  - 50% 54°F
  - 73% 62°F



NaOH Properties

- Dilution
  - Exothermic reaction
  - Always add NaOH to water
- Incompatible materials
  - Aluminum
  - Galvanized steel
  - Copper
  - Brass
  - Bronze

Chemical Unloading

- Tanker truck 4,000 gallons max load
- Level site
- Compressed air
  - On-board compressor
  - On-site compressor
- Personal protective gear
- Drench shower
- Check NaOH temperature
- Tank high level alarm

Unloading Station

- Quick connect close to the floor
- Hose support
- Room for bucket under the connection
- Sample tap

Fill Pipe & Tank Vent

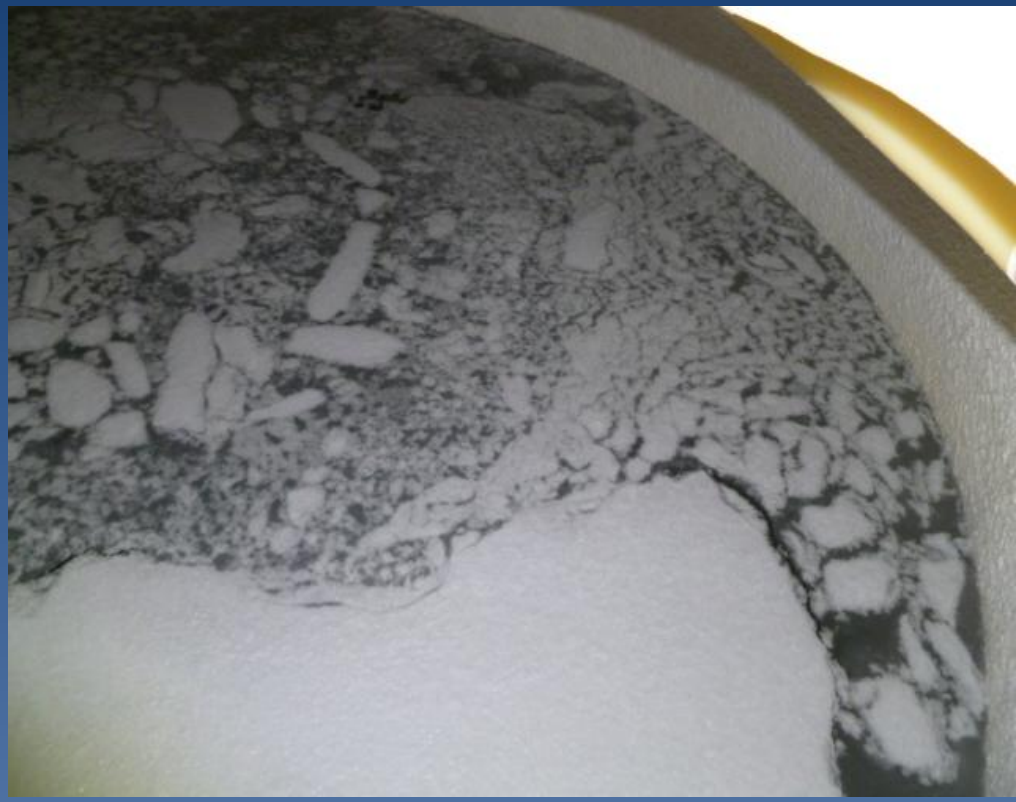
- Vent Area = 4 X Area Fill Pipe (Minimum) (1995 Chlorine Institute Pamphlet 94)
- Larger for XLPE tanks

Storage Tanks

- Volume
  - 1½ X Delivery Volume
- Materials
  - Carbon Steel with Rubber Lining
  - 304L or 316L Stainless Steel
  - XLPE or HDPE
  - FRP

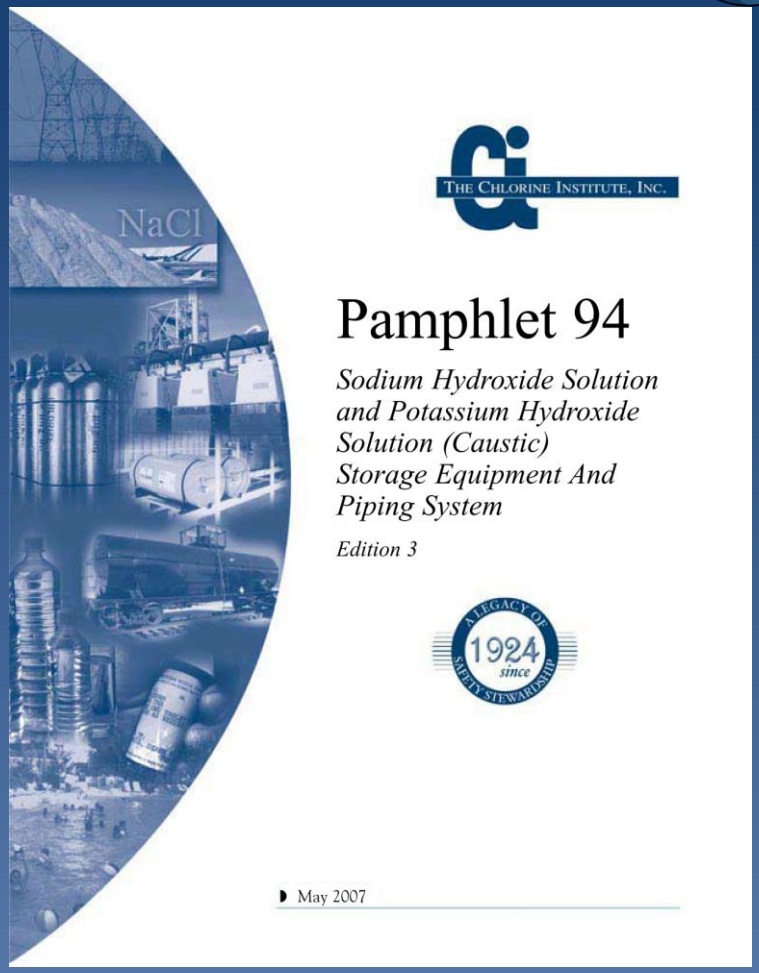
Tank "Icebergs"

- Issue is more pronounce with 50% diaphragm grade NaOH
- NaCl supersaturated as water evaporates
- CO_2 adsorbed from atmosphere
- $CO_2 + 2NaOH \rightarrow Na_2CO_3 + 2H_2O$
- NaCl & Na_2CO_3 seed
- NaCl/ Na_2CO_3/NaOH "icebergs"



NaOH Piping

- Carbon steel
- 304L and 316L stainless steel
- Monel
- Nickel
- Schedule 80 PVC

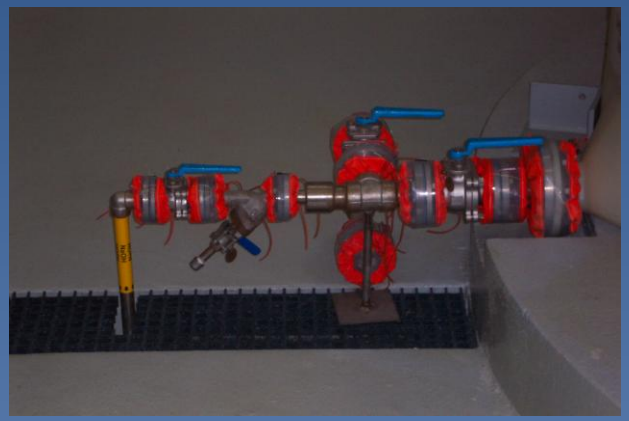


Carbon Steel Pipe

- Pros
  - High pipe strength
  - Less expensive than SS
- Cons
  - Iron pickup
  - Protective coating
  - More expensive than PVC

Stainless Steel Pipe

- Pros
  - High pipe strength
  - Non prone to corrosion
  - Does not require paint
  - Lower lifetime cost
- Cons
  - Higher initial cost
  - More difficult to replumb



PVC Pipe

- Pros
  - Inexpensive
  - Easy to replumb
- Cons
  - Lacks mechanical strength
  - Prone to leaks
  - Requires glue without fillers
  - Plumber must follow strict assembly procedure
  - PVC ball valves prone to failure
  - Some NaOH suppliers recommend that plastic pipe not be used.

Pipe Joints

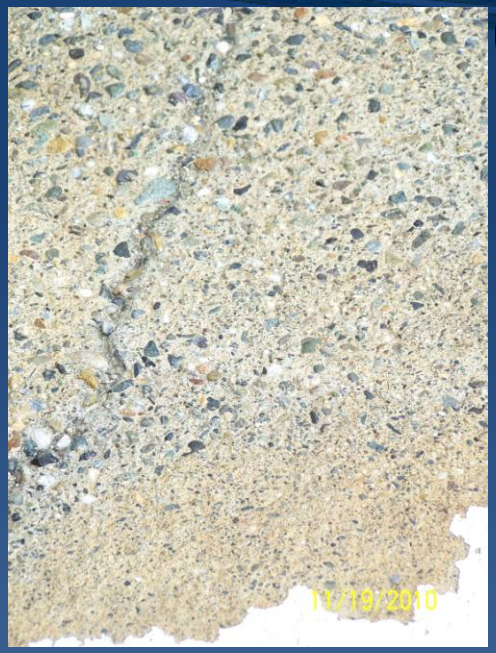
- Butt welds - preferred
- Flanged joints – preferred
  - Spray shields for pressure service
- Socket welds
  - Small diameter pipe
  - Crevice corrosion
- Threaded joints
  - Prone to leaks
    - NaOH – very low surface tension
    - Increasing problem as pressure increases > 60 psi

Metering Pumps

- Positive displacement metering pumps
- Accessories
  - Calibration column
  - Pressure relief valve
  - Pulsation dampener

Secondary Containment

- Volume
  - Largest tank + 20 min fire flow
- Containment Lining
  - NaOH will attack concrete
  - Novalac epoxy
  - Skilled applicators



Monitoring and Control

- On line pH meters
- Control signals
  - pH
  - Flow rate
- “Step and hold” process control

Safety Considerations

- Drench shower
- Eyewash
- Operator in trouble alarms
- Personal protective gear
  - Face shield
  - Rubber apron
  - Rubber gloves
  - Long sleeved protective clothing
  - NIOSH/MSHA approved respirator if mist is present (e.g. indoor vent)

Startup and Distribution Issues

- Adjust pH incrementally
  - 0.3 pH unit steps
- Conversion of CO_2 to HCO_3 is not instantaneous
- Potential reactions with scale deposits in distribution system