Sulphuric Acid Storage Tanks
Design, Operation and Maintenance

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Sulphuric Acid Storage Tanks

- Typical Corrosion problems
  - General Corrosion
  - Grooving Corrosion

- Design & Fabrication
  - Applicable Standards
  - Design Details

- Operation
  - Preventing corrosion
  - Tank filling
  - Offloading
  - Anodic protection

- Maintenance
  - Routine maintenance
  - External in-service inspections
  - Internal inspections
General Corrosion

Factors Affecting Corrosion of Steel In H₂SO₄

- Acid Temperature
- Acid Strength
- Acid Velocity
General Corrosion

Bi-products of Corrosion are:

\[ \text{Fe} + \text{H}_2\text{SO}_4 = \text{FeSO}_4 + \text{H}_2 \]
General Corrosion

Temperature

Corrosion Rate  MPY  [log scale]

Fe Content 40 ppm
General Corrosion

Fe Content 40 ppm

Corrosion Rate (MPY)

Acid Concentration (%)
Grooving Corrosion

Acid spraying on surface removes the natural sulphate film
Grooving Corrosion
Grooving Corrosion
Grooving Corrosion
Grooving Corrosion

Hydrogen form General Corrosion collects in the manway

Hydrogen cuts deep groves in nozzle

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Grooving Corrosion
Hydrogen Blistering

By-product Hydrogen will diffuse into the plate
Hydrogen Blistering

If left to propagate may ultimately rupture
Crevice Corrosion

If weld leaks the cavity will fill with acid and crevice corrosion will proceed at an accelerated rate.
Sulphuric Acid Storage Tanks – Applicable Standards

- **API 650** – Welded Steel Tanks for Oil Storage
  - Design and Fabrication
  - Limited to 2.5 psig and 200°F

- **API 620** – Recommended Rules for Design & Construction of Large, Welded, Low Pressure Storage Tanks
  - Design and Fabrication
  - Limited to 15 psig and 250°F

- **API 653** – Tank Inspection, Repair, Alteration and Reconstruction
  - Repair, Alteration and Reconstruction
  - Reliability Inspections

- **NACE SP0294** – Sulfuric Acid and Oleum Storage at Ambient Temperatures: Design, Fabrication, and Inspection of Tanks
  - API 650, API 620 and API 653
  - Better Weld Quality

- **API 2000**
  - Venting Requirements
Sulphuric Acid Storage Tanks – Design Details

- Full Penetration Butt Welds
  - Floor welds
  - Shell welds
  - Manway necks
  - Roof welds

- SINGLE VEE (T < 9/16")

- DOUBLE VEE (T > 1/2")
Sulphuric Acid Storage Tanks – Design Details

- Full penetration groove & fillet welds
  - Floor-to-shell weld
  - Manway neck-to-shell weld
Sulphuric Acid Storage Tanks – Design Details

- **Acid Inlet**
  - 316L stainless steel
  - Located at least 8 feet from sidewall or
  - Angled and directed to center of tank
Sulphuric Acid Storage Tanks – Design Details

■ Acid Outlet
  ● Alloy 20
  ● Alloy 20 Plug Valve (preferred) or Gate Valve
Sulphuric Acid Storage Tanks – Design Details

- **Shell Manway**
  - Top half with Alloy 20 for hydrogen grooving protection
  - Full Alloy 20 liner (preferred)
Sulphuric Acid Storage Tanks – Design Details

- **Vent**
  - 316L stainless steel
  - Min. size = One pipe size larger than size of acid outlet
  - Highest point in roof
Sulphuric Acid Storage Tanks – Design Details

- **Level Control**
  - Continuous
    - Resistance tape – Metritape
    - N2 bubbler
    - Radar
  - Level Switch
    - Ultrasonic
    - Optical
    - Tuning fork
    - Capacitance
Sulphuric Acid Storage Tanks – Design Details

- **Foundation**
  - I Beam
  - Concrete Ring Wall
Sulphuric Acid Storage Tanks – Weld Quality

- Acceptable Weld Defects Comparison
  - API 650 & 620
Sulphuric Acid Storage Tanks – Weld Quality

- Acceptable Weld Defects Comparison
  - NACE SP0294

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<thead>
<tr>
<th>Medium</th>
<th>Dimension mm (in.)</th>
<th>Fine</th>
<th>No. of Rounded Indications</th>
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<tr>
<td>1.0 mm (0.44 in.)</td>
<td>0.609 mm (0.024 in.)</td>
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19 mm (0.75 in.) thickness
Total permitted area 6 mm² (0.009 in.²)
Sulphuric Acid Storage Tanks – Weld Quality

- Sub-surface Weld Defects
Sulphuric Acid Storage Tanks – Operation

- **Tank Filling**
  - Monitor acid concentration and temperature
  - Monitor tank level with Metritape or bubbler
  - Do not overfill…re-direct acid to other tanks when high-high alarm comes off

- **Offloading**
  - Prevent liquid hammer…start pump with partially opened discharge valve
  - Monitor acid level…too low will cavitate pump

- **Anodic Protection**
Sulphuric Acid Storage Tanks – Operation

- Preventing Corrosion
  - Acid temperature ≤ 104°F
  - Paint tank in white color
Anodic Protection

Create an environment whereby the corrosion product exists as a protective oxide film which limits further corrosion.
Anodic Protection

Passive Range

Extremely Low Corrosion Zone

Current
Anodic Protection

Control Reference Electrode

Cathode

Monitor Reference Electrodes
Anodic Protection
Anodic Protection

93% Acid @ 25°C

Without Anodic Protection
- 30 ft.: 10.5 mpy
- 20 ft.: 11.1 mpy
- 10 ft.: 10 mpy, 10.5 mpy, 9.9 mpy

With Anodic Protection
- 30 ft.: 2.6 mpy
- 20 ft.: 2.6 mpy
- 10 ft.: 2.2 mpy, 2.3 mpy, 2.2 mpy
Anodic Protection

93% Acid @ 54°C

Without Anodic Protection
- 13.5 mpy
- 13.4 mpy
- 22.5 mpy
- 21.2 mpy

With Anodic Protection
- 2.1 mpy
- 2.2 mpy
- 2.3 mpy
- 1.9 mpy
Sulphuric Acid Storage Tanks – Maintenance

- Routine Maintenance
  - Monthly by operator looking for
    - Acid leaks
    - Shell & roof distortions
    - Localized corrosion
    - Water pooling on roof
    - Condition of vent nozzle, pump, piping, foundation, paint, access ways, grounding and anodic protection (if any)

![Roof corrosion from water pooling](image1)

![Shell leak due to weak acid formed](image2)
Sulphuric Acid Storage Tanks – Maintenance

- External In-service Inspection
  - Every 2 years (API 650 & 620)
  - Every 3 years (NACE SP0294)
    - Visual inspection on condition of tank
    - Ultrasonic thickness measurements

- Internal Inspection
  - Every 5 years (API 650 & 620)
  - Every 6 years (NACE SP0294)
    - Thorough inspection of the internals
    - Ultrasonic thickness measurements
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