Preparing Amine, Acid Gas and Sour Water Vessels for Safe Entry with the Vapor-phase Application of an Organic Solvent and Pyrophoric Oxidizing Agent

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Agenda

- Objectives of prepping equipment for maintenance
- Traditional methods of cleaning equipment
- Pros and cons of traditional methods
- Vapor-phase application of organic solvent + pyrophoric treatment
- Summary of cleaning and treating steps
- Dealing with solids and sludge in amine and sour water equipment
- Example overviews
- Typical timeline
- Results
- Breadth of RTI applications
- Summary
Cleaning Objectives

Following are typical objectives for cleaning projects:

• Create a safe environment for workers: No LEL readings, No H2S, No hydrocarbon incl. Bz, No pyrophoric substances
• Minimize or eliminate spading under fresh air – time, risky and $$
• Maintenance activities begin on time – predictable start = $$
• Maintenance activities not interrupted
• Minimize mechanical requirements of the cleaning project
• Minimize amount and toxicity of effluent to be processed

SC = Σ(Chemistry + Planning + Execution) = Success
The systems in question historically are cleaned for entry using the following methods:

- High-volume water flushes
- High-volume circulation with surfactants
- Fill and soak with chemicals
- Weak acid wash followed by neutralization
- Vapor phasing a solvent/water mixture
- Liquid treating of pyrophoric material
Pros and Cons of Traditional Methods

**Pros:**
- Low cost
- Familiarity with the processes

**Cons:**
- Slower than vapor-phased organic solvent
- Higher volume of effluent generated
- Disposal of toxic and or hazardous effluent
- More equipment intensive

SC = \( \Sigma (C_h_e_m_i_s_t_r_y + P_l_a_n_n_i_n_g + E_x_e_c_u_t_i_o_n) = S_u_c_c_e_s_s \)
RTI began cleaning with fully organic solvents in 2000. The solvent, **QuikTurn**, is vaporized by steam or hot nitrogen. The vapor-phase application removes all hydrocarbon from internal surfaces. Equipment is **clean**, not just de-gassed.

Immediately following the cleaning process, an oxidizing agent, **Quench** is injected with steam to treat pyrophoric materials.

The result>>> All equipment will be hydrocarbon free, free of toxic gases and pyrophoric substances oxidized; a safe system for maintenance work.
Following are the typical cleaning/treating steps after system is taken off-line:

1. Amine vessels are rinsed with clean water to ~9pH and drained.
2. Steam is applied to raise temperature to >110°C, venting through towers/accumulators to the flare. Low point drains are kept dry.
3. Inject solvent over a 1-3 hour period.
4. Inject oxidizer over a 20-60 minute period.
5. After ~2 hours, remove steam and change vapor space to nitrogen or atmosphere.
6. Once towers are cool enough, rinse with clean water, top down, in order to remove hydrocarbon on horizontal surfaces.
Often, amine and sour water systems contain solids/sludges in the bottom of vessels. These materials must be agitated for proper removal of contaminants and treatment of pyrophorics.

The “rumbling” technique works well to agitate the solids/sludges and allow chemicals to work as designed.

The rumble technique:
- Add a level (.5-1m) of cool water to the vessel bottom.
- Add a prescribed amount (100-400 L) of solvent to the water.
- Agitate with steam for a period of time, ~15-30 minutes.
- Empty the vessel and if badly fouled, repeat.
- Rinse out solids

After the rumble step, proceed with the vapor-phase cleaning.
Examples

Amine Absorber
Amine Regenerator
Amine Flash Drum
Sour Water Stripper
How long does this take?

Typical System Cleaning Timeline

<table>
<thead>
<tr>
<th>TASK</th>
<th>HRS</th>
<th>Days</th>
<th>Nights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amine &amp; Sour Water Tower Systems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confirm isolations and Drains - Rinse for 9pH</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Introduce steam &amp; heat up</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inject cleaning solvent into system</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pyrophoric treatment and steam dwell</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switch system to atmosphere</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rinse column</td>
<td>3</td>
<td></td>
<td></td>
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<tr>
<td><strong>Total</strong> - 16 Hours</td>
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</tbody>
</table>

Traditional methods typically take 1 – 2 days

SC = Σ(CHEMISTRY + PLANNING + EXECUTION) = SUCCESS
Typical Results

- Project completed in ~16 hours
- 0% LEL, 0 PPM H2S, hydrocarbon free (clean, not just degassed), no pyrophorics
- Equipment ready for maintenance with no additional cleaning required (inorganic materials will still be present)
- Effluent volume a function of vessel sizes; typically < 15m³
- Little solids to dispose of if rumble technique applied
The breadth applications

This technology has been successfully applied hundreds of times in North America since 2000 in all types of amine and sour water systems:

• Amine absorbers – LPG, fuel gas, High Pressure H2 recycle
• Amine regenerators – MEA, DEA, MDEA, DGA, DIPA, etc.
• Amine flash drums and sumps
• TGTU amine systems
• SRU Acid Gas KO drums
In summary:

• Use of an organic solvent followed by pyrophoric treatment, both in the vapor-phase, has been proven for close to 20 years in amine, sour water and acid gas service equipment.
• A number of safety, economic and time benefits are associated with this method.
• The process is simple, less mechanical equipment intensive and predictable.
• Completion in less than 24 hours is the norm.