Reduce Turnaround Duration by Eliminating H₂S from Flare Gas Utilizing VaporLock™ Scrubber Technology

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Objectives

• Impact of New Regulations
• Client Challenges with Turnarounds
• Process System Design
## Impact of New Regulations

<table>
<thead>
<tr>
<th>Refinery Ja Rules</th>
<th>Refinery MACT Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applications to reduce sulfide to flare systems</td>
<td></td>
</tr>
<tr>
<td>• SRU Vent/Sump Controls</td>
<td></td>
</tr>
<tr>
<td>• Flare gas treatment for $\text{H}_2\text{S}$ and $\text{SO}_2$</td>
<td></td>
</tr>
<tr>
<td>• Tank Degassing of Sour Products to Combustion Devices</td>
<td></td>
</tr>
<tr>
<td>• Temporary Flare Systems requiring $\text{H}_2\text{S}$ reduction</td>
<td></td>
</tr>
<tr>
<td>• Maintenance of Flare Gas Recovery systems</td>
<td></td>
</tr>
<tr>
<td>Applications to reduce flare loading</td>
<td></td>
</tr>
<tr>
<td>• Flareless Turnaround</td>
<td></td>
</tr>
<tr>
<td>• Flare Minimization of Turnaround/Maintenance Activities</td>
<td></td>
</tr>
<tr>
<td>• Unit Depressurization</td>
<td></td>
</tr>
</tbody>
</table>

### Refinery Technology Rules

Applications to reduce overall emissions – Similar to Ja & MACT in some cases

• Point source controls for VOCs
• SSM Exemption will require more controls on maintenance activities
Overview of Client Challenges

• Federal and State Agencies have emphasized efforts to minimize flare usage as a control device during maintenance activities
  o Refinery Ja rules address reduction of sulfides to flare systems
  o Refinery MACT rules address unit depressurization and flare minimization

• Turnaround planners now have to take into account how to meet new regulations while maintaining schedule deadlines and optimization.

• Can the flare be utilized during deinventory, chemical cleaning, and decontamination of the unit?

• Temporary combustion devices (TOs) must still meet requirements
Client Challenges

Limiting factors to utilizing existing flare systems:

- Is H₂S reduction a requirement due to the limitations of flare gas recovery systems?
- Are there capacity issues with existing vapor control systems where turnaround schedule can be delayed?
- What options are there for temporary, non-combustion, vapor control systems to maintain turnaround schedule milestones?
Case Study – Gulf Coast Refinery

- During the shutdown and decontamination process there are periods where venting needs could exceed the flare gas recovery system capacity and potentially slow down shutdown/decontamination process.

- Investigated solutions to reduce H$_2$S loading to flare system during planned turnaround:
  - Temporary treatment approaches or
  - Extend schedule by more than 3 weeks to allow for reduced contribution to flare system.
Case Study – Gulf Coast Refinery

Key Points to Solution Criteria:

- Safety of employees during process
- Minimize or eliminate delays to turnaround schedule
- Meet H₂S reduction requirements
- Not impede emergency relief to flare system in case of upset conditions
- System design must meet process safety review
Case Study – Gulf Coast Refinery

Challenges to Solution - **Active** flare line had to be addressed for:

- Bypass loop to impose a positive flow to the scrubbing system with balance of H₂S free vapors routed to flare
- Maintaining inert atmosphere with no potential oxygen introduction
- Emergency shutdown controls on temporary scrubber package in the event of a unit upset
- Elevated temperatures and potential for steam condensate
- Designed with redundancy to remain operational during decontamination operation
Vapor Point Solution

After reviewing technology options, the refinery choose VaporLock™ high efficiency liquid scrubber systems

• Vapor Point worked in conjunction with refinery engineering to develop temporary system to reduce H$_2$S concentrations routed to flare system

• Ability to target H$_2$S contaminants removal from the flare gas vapor stream, allowing VOCs to still be routed to flare

• Temporary application allowed for minimal capital expense by refinery
Flare Line H$_2$S Scrubbing Application Design Parameters

- Hydrotreater Unit 3 shutdown and decontamination was under turnaround and tied into flare line system
- Other active operating units were still lined up to the flare for safe guarding without a consistent stream lined up to flare from other operating areas
- Continuous Emission Monitoring System (CEMS) was inline of the flare line system
- Flare line is a 36 inch diameter piping with projected output flow of 5,000 scfm with a potential H$_2$S concentration of 10,000 ppm or higher during turnaround activities
- Hot tap connections were made to flare line to allow for routing of vapors out of and back into the active flare line
VaporLock™ Scrubber Unit Design

- Flare line vapors were comprised of fuel gas, decontamination hydrocarbons, H₂S, and other deinventory compounds.

- Temporary scrubber system would selectively remove only the H₂S and sulfur compounds from the flare gas vapors.

- Removal of the H₂S and sulfur compounds by use of caustic based chemistry.

\[ H_2S + NaOH = Na_2S + H_2 \]
VaporLock™ Scrubber Unit Parameters

- Wet scrubber design
- Flowrates up to 10,000 scfm
- Pressure rating to 125 psi
- Batch chemistry operation
- Temperatures <150ºF
- 90” Diameter x 25’ L
H₂S Reduction System Design

Basis of design was to reroute flare line vapors through scrubber system and reintroduce back into flare line with a reduction in H₂S contaminates

**Key Equipment Components:**

- 12” temporary piping throughout system
- 2,000 sqft heat exchangers (2 each)
- 180 bbl vertical, knock out vessels (2 each)
- 200 horsepower blowers rated up to 8,000 scfm at 8 psig (2 each)
- 90”, 125 psi H₂S scrubber vessels (2 each)
- Temporary chemistry holding tanks with associate pumps and piping
- Nitrogen trailer to maintain inert atmosphere
Process Safety Devices

- Emergency shut off control valves and emergency stop switches installed in the event of an emergency relief through the flare line
  - Isolation valves would isolate temporary scrubbing system and shut down blowers
- Nitrogen purged seals on the blowers with pressure sensors
- Oxygen meter was installed to detect any air incursion into the system from leaks
- Oxygen meter was tied into emergency shut off system in the event oxygen was detected
  - Isolation valves would isolate temporary scrubbing system and shut down blowers
- Flowmeter installed to verify flowrate of recirculation loop
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Equipment Operation During Unit Decontamination

• Client had established maximum allowable H$_2$S level into the flare header

• Outlet of the H$_2$S reduction system was monitored via downstream CEMS unit

• Wet titrations were analyzed of the scrubbing chemistry to determine available sulfide reaction

• Project resulted in maintaining H$_2$S levels below 120 ppm at the CEMS unit

• Secondary scrubber was utilized for a small duration at end of project
CEMS Data on Sulfur & H2S
H₂S Reduction Process Results

- **Reduced deinventory duration by approximately 20 days**
- Maintained H₂S levels below 120 ppm for project duration which was below Motiva’s goal
- Operated a total of 7 days, 24 hour shifts
- Zero mechanical breakdowns
- Zero schedule impacts
- H₂S reduction process system was isolated from flare header to allow for decontamination and rig down