Treatment Options for Molten Sulfur Storage and Transfer Vents

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Overview

• Introduction

• Reasons for Ventilating Tank/ Pit
  – Safety
  – Process/ Sulfur Quality requirements

• Methods
  – Sweep vapor space
  – Sparge molten sulfur

• Safety Considerations
  – Air vs Nitrogen
  – H₂S Concentrations Concerns
    • Personnel Safety
    • Explosive Risks

• Molten Sulfur Handling Configurations

• Vent Handling Configurations

• Case Study
Questions to Start

• What is my goal?
  – Sulfur purification
  – Safe vent handling only

• What are my limits?
  – Sulfur contaminants
  – Vent emissions limits

• What are my options?
  – Air or Nitrogen?
  – Existing equipment that can be used?
  – Recycle vs all new treatment equipment?
  – How do these affect air vs nitrogen decision?
Define Goals of Molten Sulfur Handling

• Safe Venting only
  – Sweep vapor space

• Purification of Molten Sulfur
  – Sparge and/or liquid-phase treatment
Sweeping Options

• Balancing Safety and Process Requirements
  – Air- safe choice
  – Nitrogen- often better process choice, but presents several challenges
    • FeS formation- need procedures for maintenance to prevent auto-ignition of pyrophoric FeS when tanks open to air
    • Nitrogen blanketing results in high H2S in vapor space
  – Blowers vs. eductors for ventilating tank or pit
Sparging Options

• Pit or tank design
  – Design for pressure, or have “push-pull” configuration for sparge air

• Sparge air requirements
  – Sufficient air for stripping contaminants from sulfur
  – Balance with air requirements for H2S concentration control
Sulfur Purification Options

• Liquid Phase Treatment
  – Additive only
  – Additive + sparging
  – Additive + mechanical action

• Sparging for purification of sulfur

• Combination of both above
Sulfur Purification- A Combined Approach

- Often proprietary package systems, utilizing chemical additive, mechanical contacting, and air sweep or sparging

- Several systems available
Vent Handling

• Selection of System - Process Type
  – Destruction/ Conversion of H2S
  – H2S Recycle
  – H2S Removal

• Sizing of System
  – Flow limitations
  – H2S concentration limitations
Vent Handling

• Destruction/ Conversion of H₂S
  – Thermal or Catalytic incineration
  – Flare

• Need to consider emission limits for SO₂

• Combustion equipment must be designed for corrosive service
Vent Handling

• H2S Recycle
  – Most often used where existing Claus plant present, and capacity available for additional gas flow
  – Often reason for using nitrogen as blanketing gas- to minimize air recycle
Vent Handling

• H2S Removal
  – Regenerable vs Non-regenerable (scavenger) process
    • Calculated H2S load < 200 lbs/ day-
      scavenger
    • > 200 lb/ day H2S load- regenerable process most economical
    • Higher capital cost of regenerable process offset by significantly lower operating costs
      ($0.15-0.20/ lb vs $5-10/ lb H2S removed)
H2S Removal Options

- Non-Regenerable (Scavenger) Processes
  - Solid Scavengers
    - Activated carbon, iron sponge, iron or zinc oxide-based media, or solid oxidizer media
    - Simple single or dual vessel systems
    - High temperature treatment tends to favor iron or zinc oxide medias.
    - Iron oxide most economical for H2S removal.
  - Liquid Scavengers
    - Triazine, nitrate, or amine-based products
    - Only cost effective at low (< 100 lb/ day H2S) loads.
    - Simple systems, but water-based system will require high water make up, and sulfur condensation in solution will create slurry for disposal.
H2S Removal Options

• Regenerable Processes
  – Liquid Redox
  – Direct Oxidation
  – Non-aqueous liquid systems

• Most create solid, elemental sulfur product
  – Differences lie in process chemistry and complexity

Most regenerable processes are higher capital cost than scavenger systems, with < 3 year payback on systems with > 200 lb/ day H₂S removal.
What is LO-CAT?

• LO-CAT is a regenerative desulfurization process used to sweeten sour gas streams in a wide variety of industries.

LO-CAT

Liquid Oxidation Catalyst
How does LO-CAT Work?

- Aqueous-based, ambient temperature process
- Converts H₂S to elemental sulfur
- Employs a chelated-iron catalyst
- Reactions are not equilibrium limited
- Removal efficiencies of 99.9+% can be obtained in one step
- 100% turndown
- Operator attention requirements of 2 – 4 man hours per day
- 99% On-stream reliability

• There are no known poisons to the LO-CAT catalyst!
How does LO-CAT Work?

- Spent Air
- Solution Regeneration
- Solution Separation
- Regenerated Solution
- Liquid Filtrate
- Spent Air
- Solids Filtration
- Filtered Sulfur and Water
- Air
- Sulfur Slurry
- Reduced Solution
- Gas Contacting
- Sweet Treated Gas
- Sour Gas
H2S Removal Case Study

• Experience with LO-CAT Process treating 1000 TPD molten sulfur storage and transfer facility
  – Vent from storage and transfer pits sparging and sweep air
  – Significant changes in load as tanks are loaded and unloaded
  – Expansion has nearly doubled H2S load to system over last 13 years, with little change in system capacity
Industries served by LO-CAT®

LO-CAT® will treat any gas stream that requires H₂S removal.

- Oil Refineries
  - Fuel Gas
  - Amine Acid Gas
  - Sour Water Stripper offgas
  - HDS Recycle Gas
  - Molten Sulfur Storage Ventilation
- Associated Gas from oil production
- Natural Gas Processing Plants
- Syngas from gasification processes
  - Coal and waste gasification syngas feeds
  - Fuel and chemical feedstock products
- Biogas from municipal/ industrial sludge digesters
- Landfill Gas
- Non-Condensable Gas from geothermal power plants
- Coke Oven Gas
- Specialty Chemical Plants off-gases
- WWTP (digesters/odor control)
- Sour Air
Thank You

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