

Eliminating H₂S & SO₂ Emissions at SRU, Coker and Other Sulfur Handling Units of Refineries

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Agenda

- What are H₂S & SO₂?
- What is driving change?
- How are H₂S & SO₂ removed?
- Case Studies
- Challenges to Sulfur Removal
- Benefits of Sulfur Removal



1. DCU Compressor De-Inventory
2. Full DCU De-Inventory
3. SRU Incinerator Maintenance
4. Hydrotreater De-Inventory



What are H_2S & SO_2 ?

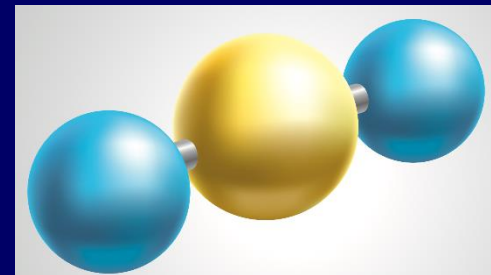
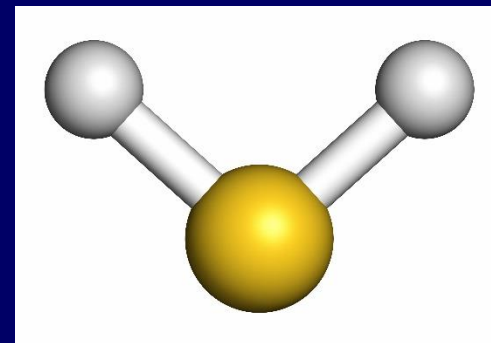
Both occur naturally and emerge from refining processes of sour crude.

Hydrogen Sulfide (H_2S) - OSHA

- Colorless, flammable, and extremely hazardous gas
- Heavier than air – collects in low laying areas
- Smell detection at 0.5 ppb (“rotten egg”)
- Possibly deadly at concentrations ≥ 500 ppm

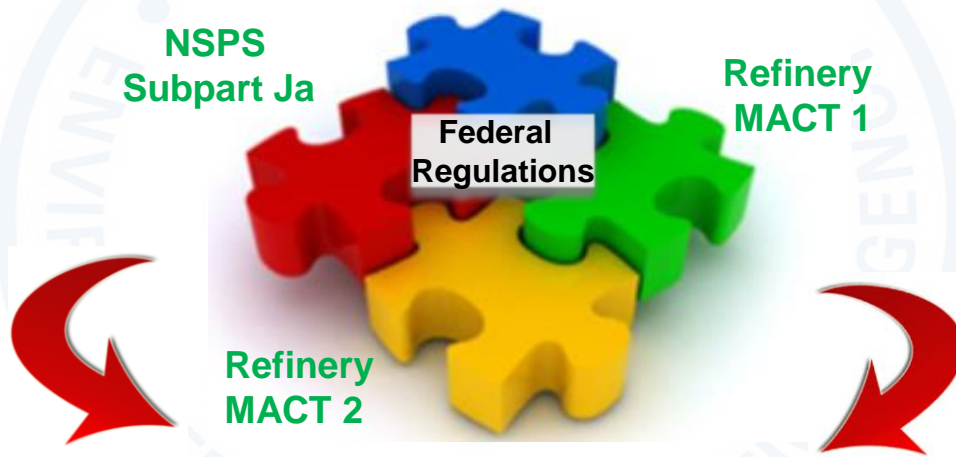
Sulfur Dioxide (SO_2)

- H_2S and Oxygen burn to form SO_2 and water
- Per the EPA, SO_2 and other oxides contribute to acid rain
- Affects both, health and the environment



What is driving the change?

The Federal Environmental Protection Agency (EPA) and state enforcement agencies have placed more stringent regulations that directly impact flare operations.



Translates into significant operational downtime and unplanned interruptions leading to additional costs and loss of production at refineries (i.e thermal destruction devices)

How are H_2S & SO_2 removed?

Commonly through one or several of the following methods:

Thermal Treatment

- Creates Sulfur Oxides (SO_x)



Specialized Activated Carbon

- Requires offsite waste disposal



Liquid Scrubbing

- Requires proper handling and disposal

Amine Treating

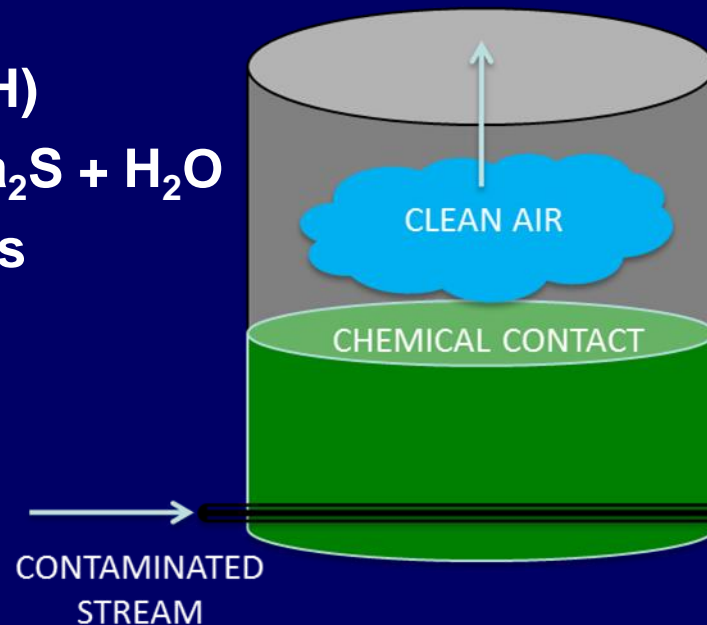
- Capital extensive and typically only used as a process



Scrubber Vessel

Liquid Scrubbing:

- Liquid caustic (NaOH)
 - $\text{H}_2\text{S} + \text{NaOH} = \text{Na}_2\text{S} + \text{H}_2\text{O}$
- Specialty chemistries (scavengers)



Case Studies from Refineries

Gulf Coast Refinery challenged with the complete de-inventory of their DCU

- Restrictions on flare SO_2 emissions caused very slow purge of operating components

Project Goals

- Reduce the H_2S concentration from vapors being routed to the flare header
 - Max expected H_2S levels at 18% or 180,000 ppm
- Implement a liquid scrubbing system to meet the specified targets
 - Max H_2S : 160 ppm. Operate at flow rates as high as 2,000 cfm
 - ASME coded vessels required (MAWP > 50 psig)
- Reduce the historical downtime associated with the de-inventory process
- Reduce exposure and increase safety for all personnel

1 – Delayed Coker Unit (DCU) De-Inventory



Solution

- Dual – 90” liquid scrubbers arranged in “series”
 - ASME coded (rated to 75 psig)
- Reverse manifold to bypass flare line into scrubber system. Treated gas back to flare line
 - Single scrubber operation or lead/lag conf.
- 1,000 gallons specialty chemistry in each
 - H₂S loading capacity = 1,700 lbs
 - Max expected = 1,150 lbs (50% safety factor)
- Perimeter H₂S monitoring system



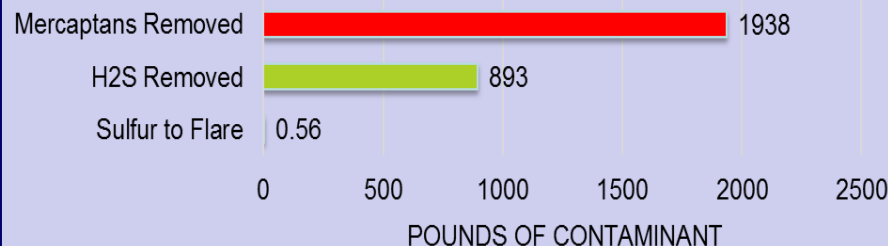
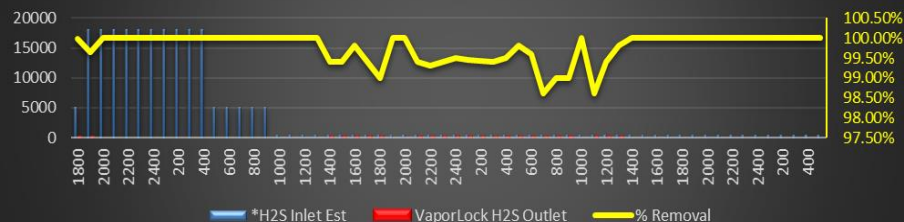
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Results and Achievements

Significant time reduction, 30 days, as the dual scrubbers were in operation for approx. 62.5 hrs

- VaporLock™ system provided 99.76% removal of H₂S (5 gas meter & drager tube samples)
- Due to safety hazards of H₂S exposure, inlet concentrations were “calculated”
- Analysis of the spent scavenger demonstrated effective removal of H₂S and mercaptans
 - Calculated (lbs) emitted to flare line was only 0.56 lbs

DCU Sulfur Removal Performance



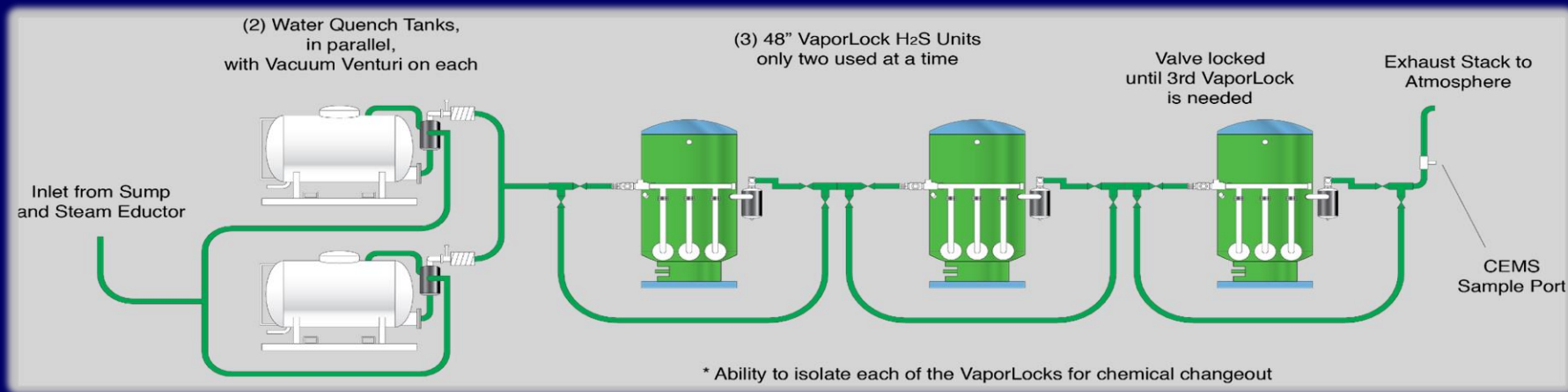
South Louisiana Refinery challenged by controlling H₂S and SO₂ emissions while keeping their Sulfur Recovery Unit (SRU) in operation

Project Goals

- **Implement a liquid scrubbing system to meet the specified objectives**
 - **Pull vacuum on the sulfur pit**
 - **Remove H₂S and SO₂ vapors**
 - **H₂S concentration ranging between 500 and 100,000 ppm**
 - **Temp > 300 deg F due to use of steam eductor**
 - **Exhaust flow rate = 180 CFM**
 - **Allow workers in the area to work without fresh air system**
- **Reduce exposure and increase safety for all personnel**
- **Estimated project duration: 45 days**

Solution

- Two (2) Water Quench Tanks arranged in parallel with vacuum venturi on each
 - Removes sulfur dust and reduce temperature
- Three (3) x 48" ASME coded Liquid Scrubber Vessels (2 used in series, 1 backup)
 - Each unit can be operated and isolated independently



Results and Achievements

- System operated for 39 days
- No safety incidents or accidents
 - Elevated temperatures
 - Elevated H₂S concentrations
- No detectable H₂S or SO₂ was recorded
 - Continuous monitoring provided by a 3rd party
- No facility downtime caused by the treatment process



3 – HydroTreater De-Inventory

- A South Louisiana Refinery to perform turnaround on their Hydrotreater Unit and expected to generate over 630 lbs of H₂S during a 5 day period
- Wide range of H₂S concentrations and flow rates during different phases of unit cleaning

	Stage 1	Stage 2	Stage 3	Stage 4
Avg. H ₂ S Conc. (ppm)	989	431	388	410
Max H ₂ S Conc. (ppm)	3249	5226	1554	1413
Max Air Flow (MSCFH)	40	173	164	153

3 – Hydrotreater De-Inventory

Solution

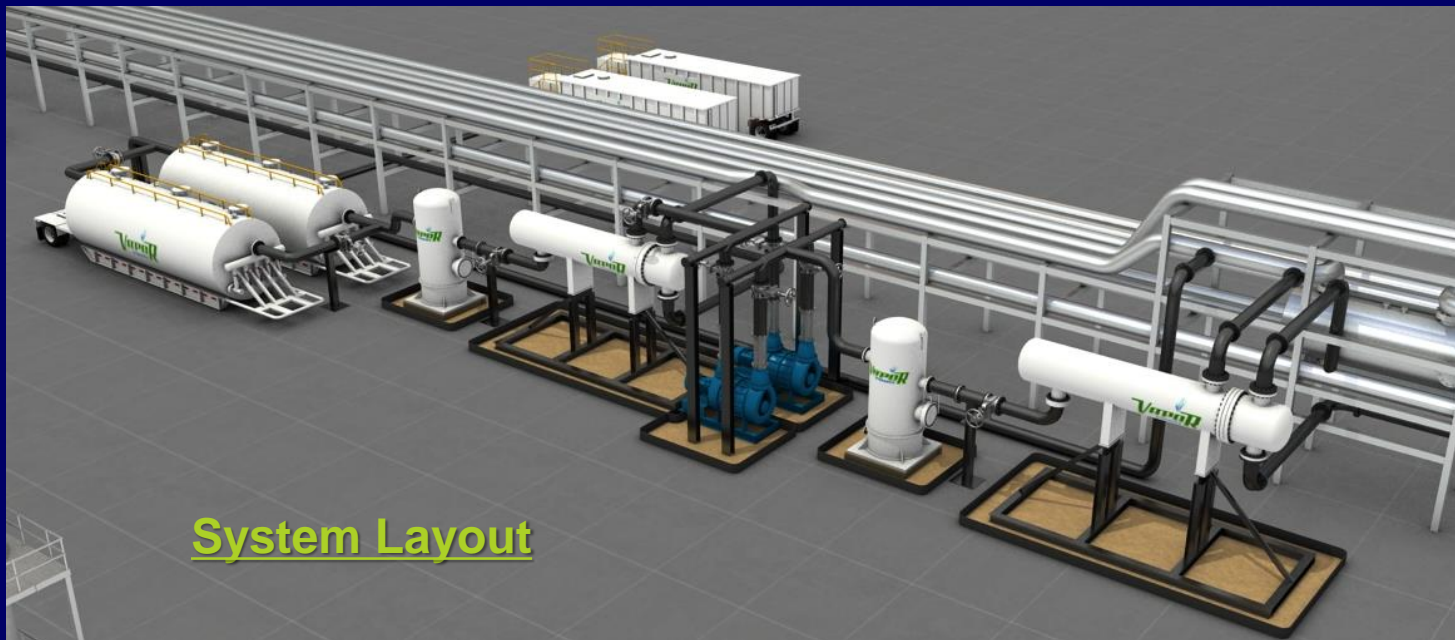
- Implement a temporary proprietary caustic treatment system
- Two (2) x 200 bbls, 125 psi VaporLock™ scrubbers
 - Vapor / Chemical interaction
 - One for backup
- Two (2) Electric Driven Vacuum Pumps rated for 4000 CFM each
 - Heat exchangers
 - Liquid knockout drums
- Diaphragm pumps and storage tanks
- Resulting sweet gas is then routed to the client's flare system



3 – HydroTreater De-Inventory

Achievements

- System resulted in the reduction of outage time by up to 20 Days
- Managed H₂S outlet conditions to ensure plant complied with Ja limitations



System Layout

Challenges to Sulfur Removal

- **Operating conditions of the refining units**
 - Liquid carryover, high temperatures, high pressures
- **Personnel Safety**
 - High exposure risks to toxic / harmful effluents
 - Breathing air requirements
- **Chemical Hazards**
 - Special PPE when loading scavenger chemistries
- **H₂S Monitoring**
 - Handled electronic meters typically range from 0 to 200 ppm
 - Drager / Sandidyne tubes have ranges of effectiveness



- **Safer working conditions**
 - **Decrease in breathing air requirements**
- **Reduced downtime during turnarounds**
- **Minimized SO_x Production**
- **Reduced corrosion potential in flare lines and other system components**
- **Commercial and marketing opportunities for cleaner fuels**
- **Compliance with newer and more stringent regulations**



Thank you for your time & interest.

Questions?