Hydrocarbon Contamination to Amine and Sour Water Stripper Units Affecting the Sulfur Recovery Process - A Domino Effect

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Sulfur Recovery Units

\[ 3 \text{H}_2\text{S} + \frac{3}{2} \text{O}_2 \Rightarrow \frac{3}{x} \text{S}_x + 3 \text{H}_2\text{O} \]

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Sulfur Recovery Process

Acid Gas Feed Into SRU Originates at Amine and Sour Water Stripper Units

Amine Units
Sour Water Stripper Units
Sulphur Recovery Units

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Sulfur Recovery Process

Amine and Sour Water Stripper Units Feed originates from many Refinery units

FCC, Hydrotreater, Hydrocracker, Coker

FCC, Hydrotreater, Hydrocracker, Coker, Amine Unit, Crude Unit and others

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Amine and SWS Unit Feed Contaminants

**Amine Units**
- Hydrocarbons
- Surfactants
- BTEX
- Methanol
- Glycols
- Process Additives
- Solids

**SWS Units**
- Hydrocarbons
- Surfactants
- BTEX
- Phenols
- Process Additives
- Amines
- Solids

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Main Chemical Reactions

Amine Treating

\[ \text{H}_2\text{S} + \text{NR}_3 \leftrightarrow \text{HNR}_3\text{SH} \leftrightarrow \text{NR}_3 + \text{H}_2\text{S} \]  

(HNR$_3^+$ + HS$^-$)

Sour Water Stripping

\[ \text{NH}_4^+ + \text{HS}^- \leftrightarrow \text{NH}_4\text{SH} \leftrightarrow \text{H}_2\text{S} + \text{NH}_3 \]
Contaminants in SRUs

Effects on the Claus process

- Hydrocarbons consume large amounts of oxygen in the reaction furnace, affecting $\text{H}_2\text{S}:\text{SO}_2$
- Cause unstable operation

Potential catalyst soothing and deactivation

- Plant can’t always supply the necessary $\text{O}_2$ for HC combustion
- Catalyst Fragmentation

Discolouration of Sulfur

- Leading to poor quality product

Decrease plant capacity

Emissions
Carbon Contamination from Hydrocarbon Activated Alumina Catalysts

External Powder (Soot)

Hydrocarbon Cracking (BTEX)

Glassy HC Coating (Amine)

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Water Feed Quality to SWS Units
Feed Gas to Amine Units
Amine Regenerator Reflux Water
Rich Amine Hydrocarbon Contamination
Hydrocarbons Water

Free Hydrocarbons
• Separate easily from water
• Removed in flash and holding tanks

Soluble Hydrocarbons
• pH, pressure and temperature dependent
• Not readily visible
• Dependent on amine type/water temperature

Emulsified Hydrocarbons
• Held in water by surfactants (similar to soaps or detergents)
• Range from 2 – 500 microns size droplets
• Take weeks to separate naturally

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Hydrocarbons Water

Free HC

Dissolved HC

Emulsified HC

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Minimizing Hydrocarbons in Amine Unit

1. Minimize hydrocarbon content of gas feeds
2. Optimise operation of the amine absorber
   a) Recirculation rate
   b) Delta Temperature (feed gas to lean amine)
   c) Lean amine loading mol/mol
3. Optimise flash tank operation
4. Utilizing skimming connections
5. Utilize filtration & coalescing technology
   a) Feed Gas
   b) Rich Amine
Basic Inlet Separators (Demisters)

- **Bulk separation** of liquids slugs
- Demister pad provides removal of liquid droplets down to 10-20 micron at best
- Cant handle well high solids content

Important Aspects
- Level controller
- Differential pressure
- Demister pad
- Bulk liquid volume

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Submicron Coalescers

Free Liquids and Aerosols

Vertical design has two chambers

Good efficiency for large liquid droplets down to 0.1 microns

Vessel design is critical

Instrumentation-intensive

Last line of defense system

Sub-Micron Coalescers

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Rich Amine/Sour Water Feed Filtration & Coalescing

Traditional “filtration” is for solids removal
  • Emulsified HC penetrate filtration media

Coalescers remove (and recover) HC from amine
  • Emulsified droplets smaller than 15-20 microns will not separate in the flash tank

Main HC Separation Technologies:
  • Inclined plates (don’t have the efficiency)
  • Metal mesh (metal fibers, easily fouled)
  • Centrifuges (emerging technology, low flow/pressure)
  • Micro-fiber coalescers. RECOMMENDED
  • Carbon beds should NOT be used (only for solubles)

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Real Cases

Amine Units

SWS Units

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