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

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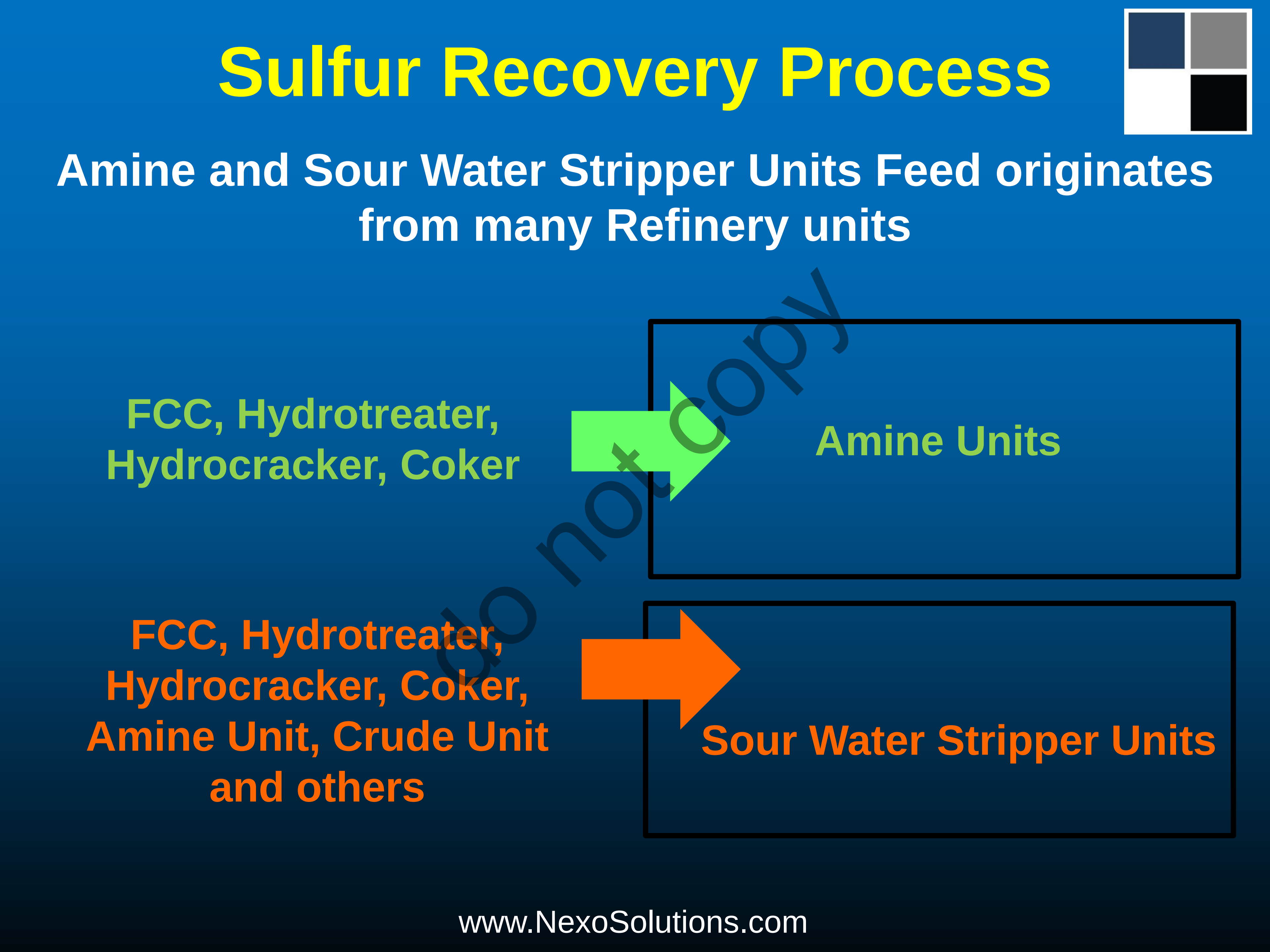
Sulfur Recovery Units

$$3\ H_2S + {}^{3}/_{2}\ O_2 \Rightarrow {}^{3}/_{x}\ S_x + 3\ H_2O$$

Sulfur Recovery Process

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


Sulfur Recovery Process
Amine and Sour Water Stripper Units Feed originates from many Refinery units
FCC, Hydrotreater, Hydrocracker, Coker
Amine Units
FCC, Hydrotreater, Hydrocracker, Coker, Amine Unit, Crude Unit and others
Sour Water Stripper Units
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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

Main Chemical Reactions

Amine Treating

$$H_2S + NR_3 \longleftrightarrow HNR_3SH \longleftrightarrow NR_3 + H_2S$$

$$(HNR_3^+ + HS^-)$$

Sour Water Stripping

$$NH_4^+ + HS^- \longleftrightarrow NH_4SH \longleftrightarrow H_2S + NH_3$$

Contaminants in SRUs

Effects on the Claus process

- **Hydrocarbons consume large amounts of oxygen in the reaction furnace, affecting $H_2S:SO_2$**
- **Cause unstable operation**

Potential catalyst soothing and deactivation

- **Plant can't always supply the necessary O_2 for HC combustion**
- **Catalyst Fragmentation**

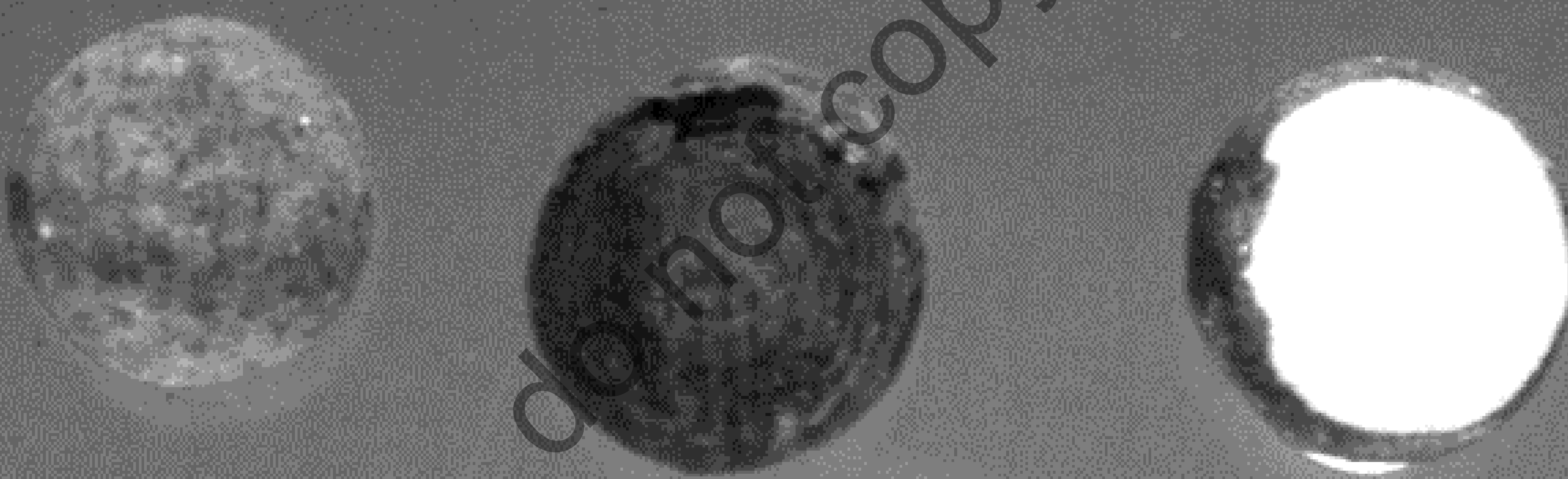
Discolouration of Sulfur

- **Leading to poor quality product**

Decrease plant capacity

Emissions

Carbon Contamination from Hydrocarbon Activated Alumina Catalysts



External Powder

(Soot)

Hydrocarbon Cracking

(BTEX)

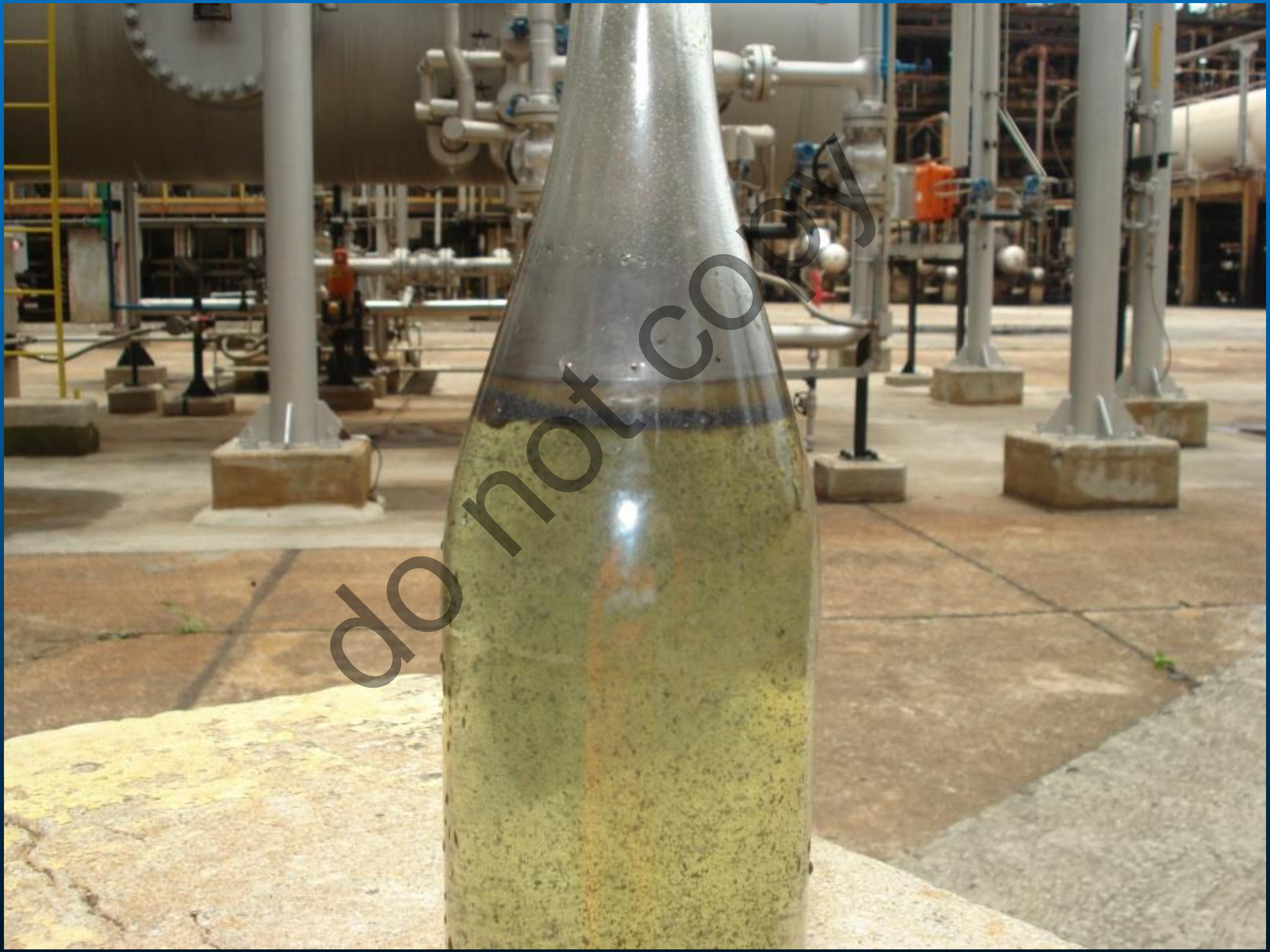
Glassy HC Coating

(Amine)

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

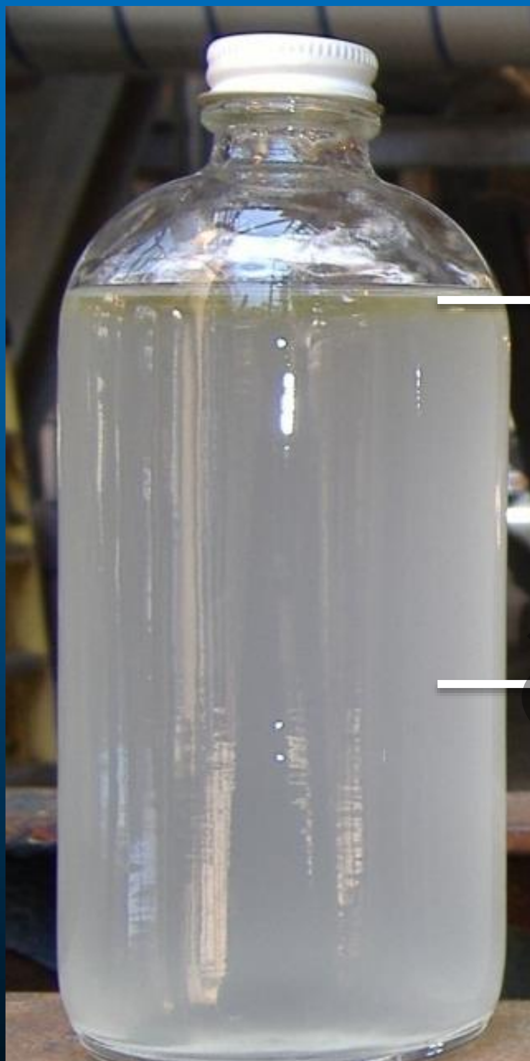
Soluble Hydrocarbons

- 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

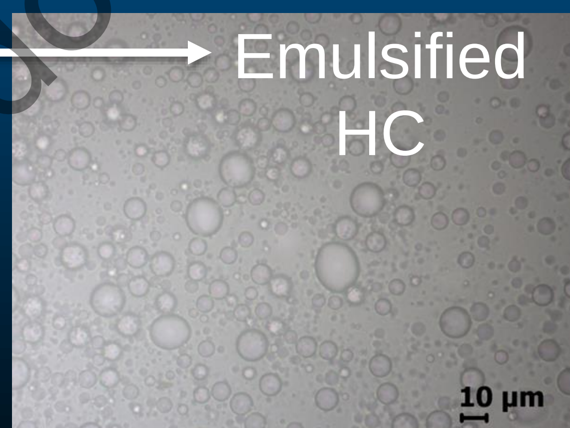
Hydrocarbons Water



Free HC

Dissolved HC

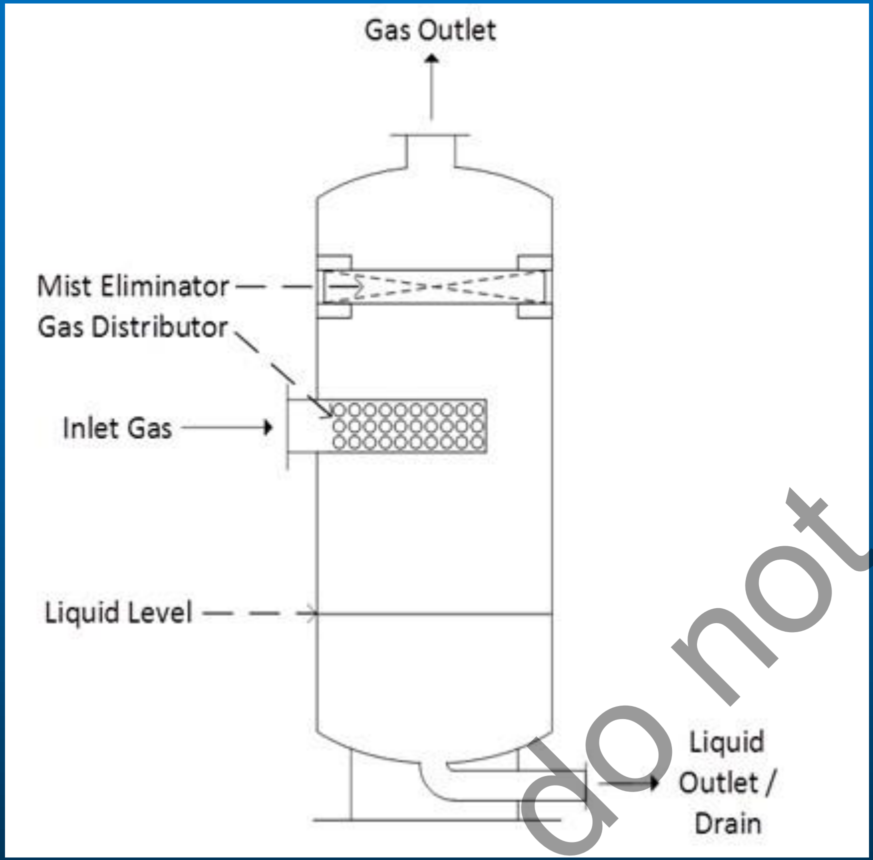
Emulsified HC



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)



Important Aspects

- **Level controller**
- **Differential pressure**
- **Demister pad**
- **Bulk liquid volume**

- **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

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

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

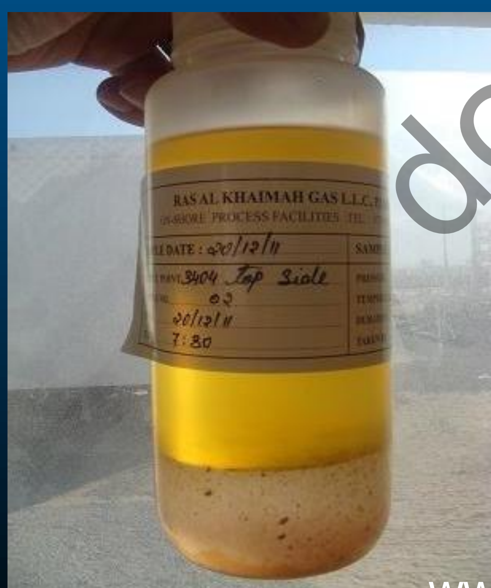
- Emulsified droplets smaller than 15-20 microns will not separate in the flash tank

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 (<u>only</u> for solubles)

Real Cases

Amine Units



SWS Units