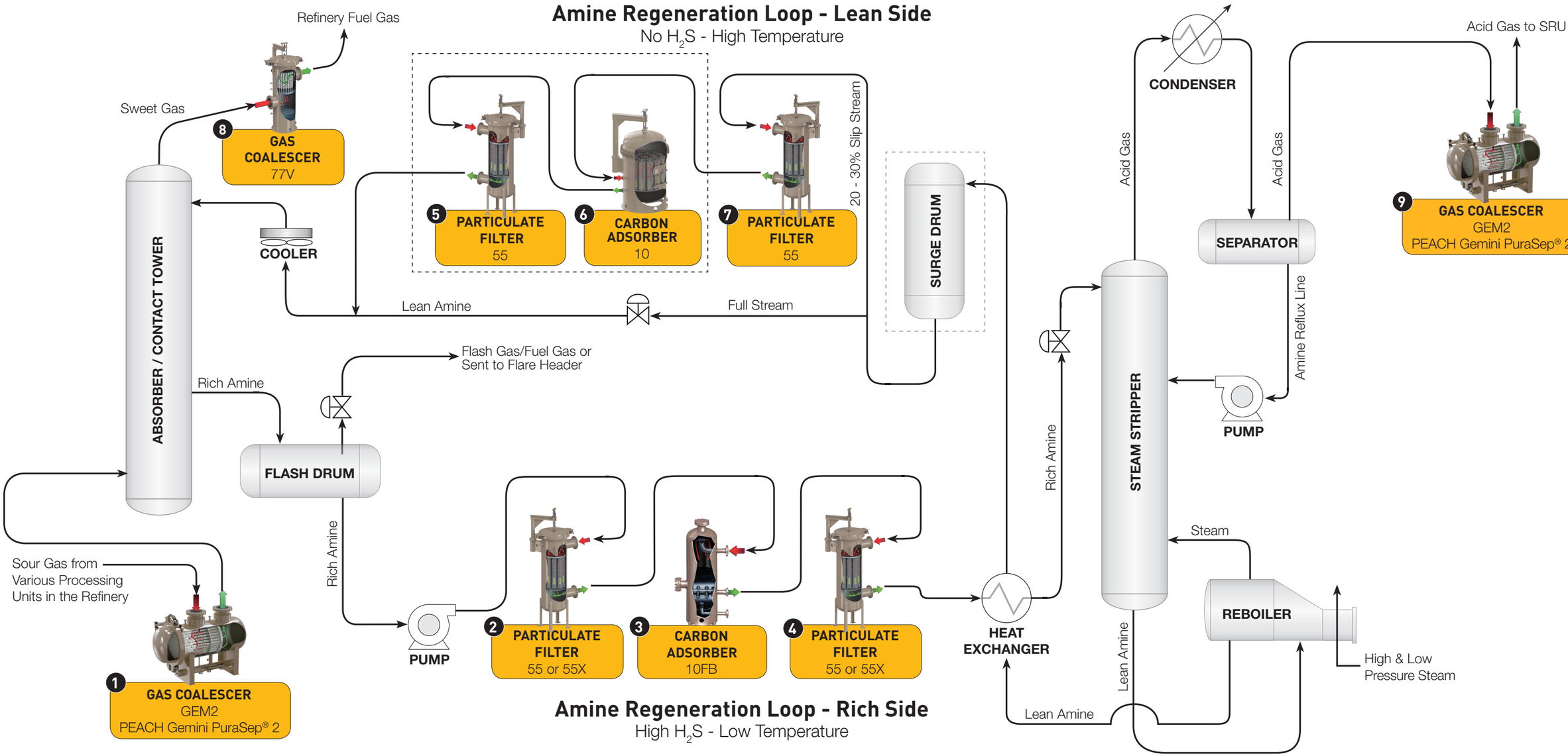
REFINERY - AMINE UNIT

FILTRATION & SEPARATION EQUIPMENT



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REFINERY - AMINE UNIT

FILTRATION & SEPARATION EQUIPMENT

PROCESS UNIT

- Amine Treating Unit (ATU)
- Acid Gas Recovery Plant (AGRP)
- Refinery Amine Sweeting Plant

CONTAMINANTS

Amine contaminants can be grouped into five distinct categories:

1. Heat Stable Salts
2. Degradation Products
3. Injection Chemicals
4. Hydrocarbons
5. Particulates

OBJECTIVES OF AMINE TREATING UNIT

- Complete removal of H_2S from the incoming feed gas
- Produce sweet gas for refinery use
- Separate acid gas from rich amine stream, which then becomes feed to Sulfur Recovery Unit to recover elemental sulfur

DIRTY AMINE: SYMPTOMS

Symptoms of a dirty, corrosive amine system are:

- Carryover of amine from the absorber & stripper
- Dilution of the amine system with water due to re-boiler leaks
- Plugging of instrument taps with particulates in the amine
- Loss of amine because of leaks
- Rich amine leaking into lean amine in the cross heat exchanger

PROCESS DESCRIPTION

The objective of the Amine Treating Unit is to remove H_2S, CO_2 and mercaptan compounds from various gas streams, such as recycled gas in hydrotreating and hydrocracking processes, hydrogen plant feed, and fuel gas systems. The H_2S recovered is used as feed for the Sulfur Recovery Unit (SRU).

Gas containing hydrogen sulfide (H_2S) is generated as a result of the hydrotreating process. Amine is used for selective removal of H_2S often referred to as “Acid Gas”.
Acid gas is introduced to the bottom of the absorber (contact tower) while an amine/water combination is introduced at the upper section of the contactor. As the streams circulate and come into contact with one another, the amine removes the acid gas by absorption. The rich amine is then fractionated to separate and remove the hydrogen sulfide. The lean amine, which is stripped of the hydrogen sulfide, is recycled back to the contact tower.

COLOR OF AMINE – THE KEY INDICATORS

Bright and clear: Amine is in excellent shape. A yellow tinge indicates the presence of iron, but this is of no great consequence.

Grayish cast: Solution is a pale, dull gray. Objects can be seen through the bottle without difficulty. This is okay; however, do not let the amine solution get dirtier.

Translucent black: Objects can barely be seen through the bottle. Upon standing 10 minutes, a small amount of sediment is visible. You are now in trouble. Erosion-corrosion is generating particulates faster than they can be removed.

Opaque black: Give the bottle a good shake. If you notice a lot of particulates settling in the bottle then this could cause fouling in critical equipment such as the absorber, stripper, heat exchanger and reboiler.

Brownish: Air is getting into the system. Oxidized amine is corrosive.

FEED TO THE UNIT

Sour Gas from various Refinery Hydrotreating Unit’s and off gases form other refinery processing units.

AMINE TREATMENT PROCESS VARIABLES

Absorption Temperature:
A lower lean amine temperature affords better H_2S removal, usually between 80–105° F (27–41° C)

Amine Concentration:

- 15–20% amine concentration for MEA (monoethanolamine)
- 20–30% amine concentration for DEA (diethanolamine)
- 35–45% amine concentration for MDEA (mono diethanolamine)

Optimum amine concentration allows H_2S removal with the lowest heat requirement.

Variables that Induce Corrosion:

- High Temperature
- High Acid Gas Loading
- High Amine Concentration
- High Contaminants

Variables that cause Foaming/Fouling:

- Hydrocarbons
- Corrosion Products

KEY ISSUES

Running a sulfur recovery operation with dirty amine is analogous to deficit spending. The insidious aspect of circulating dirty amine is its erosive nature. Carbon steel is corroded by clean amine. However, the sulfide products of corrosion stick to the metal surfaces and inhibit further attack. Particulates in the circulating amine erode this protective layer. New metal is exposed to corrosion and then more particulates are generated as the corrosion-erosion cycle perpetuates itself. This environment is manifested by several signs:

Foaming
Dirt reduces the surface tension of liquids. Particulates will cause amine to foam. Foaming in the regeneration system stripper results in high amine concentrations in the regenerator reflux water. Foaming in the absorber causes amine to be carried overhead with the inlet sour gas being scrubbed.

Plugged Instrument Taps
Flow rates in dirty amine systems tend to be erratic. Orifice taps on flow meters and level taps on float chambers often plug. Level control in the bottom of the absorber and stripper becomes unreliable and massive carryover of amine is frequent.

Condenser Fouling
Rich amine regenerator feed splashes overhead. Particulates accumulate in the regenerator condensers, heat transfer is impaired to a certain extent, and the reflux temperature rises. This results in amine carryover.

Reboiler Tube Failures
Enhanced corrosion rates are most evident in the regenerator reboilers. Dirty amine has caused tube failures after six months of service.

Filter Plugging
The dirtier the amine, the shorter the filter life. The shorter the filter life, the dirtier the amine. For really bad amine, filter pressure drop can increase by 1 psi per hour.

Regenerator Flooding
Eventually, dirty amine plugs the regenerator trays in the stripper and the massive carryover of liquid which follows shuts down the SRU.

FILTRATION SOLUTIONS

FEED, SOUR GAS FILTRATION

❶ Gas Filter-Coalescer
PECO, PEACH Gemini PuraSep® 2, Series GEM2 horizontal coalescer with PGC cartridges

- High efficiency 0.3 micron coalescer
- Prevents hydrocarbon liquid & solids from entering the amine loop
- Reduces amine foaming
- Improves acid gas throughput
- Lowers antifoam consumption
- Reduces amine makeup
- Provides higher acid gas removal efficiency
- Lowers energy consumption in Reboiler
- Protects Absorber Contact Tower
- Lowers amine unit operational costs

RICH AMINE FILTRATION (usually full flow)

❷ Liquid Filter
PECO, XtreamPure®, Series 55X Filter with 6” diameter XP cartridges or PECO, Series 55 Filter with 2.5”/3” diameter PEACH® P90/PPL cartridges

- Minimizes solid contaminants in amine
- 20 micron filtration or smaller recommended
- Reduces fouling in Heat Exchanger, Reboiler, Stripper

❸ Carbon Adsorber
PECO, Series 10 carbon adsorber with bulk activated carbon or PECO, Series 10FB carbon adsorber with activated carbon canisters

- Carbon prevents degradation products & liquid hydrocarbons in amine
- Carbon needs to be changed on a regular basis

❹ Liquid Filter
PECO, XtreamPure®, Series 55X Filter with 6” diameter XP cartridges or PECO, Series 55 Filter with 2.5”/3” diameter PEACH® PPL/P90 cartridges

- High efficiency filter that minimizes solids in amine
- 20 micron filtration or smaller recommended
- Post carbon filter that removes carbon fines from amine

LEAN AMINE FILTRATION (20-30% slip stream)

❺ Liquid Filter
PECO, Series 55 Filter with 2.5”/3” diameter Hot/Chem PEACH® HCP cartridges

- Minimizes solid contaminants in amine
- Handles high temperature amine
- 20 micron filtration or smaller recommended

❻ Adsorber Filter
PECO, Series 10 carbon adsorber with activated carbon canisters

- Carbon prevents degradation products & liquid hydrocarbons in amine
- Carbon needs to be changed on a regular basis

❼ Liquid Filter
PECO, Series 55 Filter with 2.5”/3” diameter Hot/Chem PEACH® HCP cartridges

- Minimizes solid contaminants in amine
- Handles high temperature amine
- 20 micron filtration or smaller recommended
- Post carbon filter that removes carbon fines from amine

REFINERY FUEL GAS (Sweet Gas)

❽ Gas Coalescer
PECO, Spartan PuraSep® Series 77V vertical coalescer with NGGC cartridges

- High efficiency 0.3 micron coalescer
- Removes liquid carryover from the sweet gas
- Liquid carryover can cause issues with the downstream Refinery Fuel Gas system

ACID GAS TO SULFUR RECOVERY UNIT

❾ Gas Filter-Coalescer
PECO, PEACH Gemini PuraSep® 2, Series GEM2 horizontal coalescer with PGC cartridges

- High efficiency 0.3 micron coalescing & solids removal
- Removes particulate and liquid carryover from the acid gas
- Acid gas after the Steam Stripper goes to the Sulfur Recovery Unit (SRU) to be processed
- Contaminated acid gas affects the yield of Sulfur in the SRU as these contaminants impact the functionality of the Claus catalyst