Sulfur and Ammonia Calculations
To Demonstrate Compliance with BAAQMD 9-1-313.2

Calculation: Refinery Fuel Gas Sulfur Removal and Recovery Efficiency on Refinery Wide Basis

Sulfur in Untreated Fuel Gas =	122	LT/D
Ideal gas volume at 60 degrees F =	380	standard cubic feet per lb-mol
Molecular weight H_2S =	34	
Molecular weight SO_2 =	64	
Molectular weight COS =	60	
Molecular weight S =	32	
Long ton (LT) =	2,200	lbs

Refinery Fuel Gas

H_2S daily average concentration =	10	ppmvd
Daily average flow rate =	58	MMscf/day

Sample Calculation:

Refinery Fuel Gas Sulfur Emissions (LT/D) =

$$58\ \frac{\text{MMscf gas}}{\text{day}} \times 10\ \frac{\text{scf } H_2S}{\text{MMscf gas}} \times \frac{\text{lb-mol}}{380\ \text{scf } H_2S} \times \frac{32\ \text{lb S}}{\text{lb-mol}} = 49\ \frac{\text{lb S}}{\text{day}} \times \frac{\text{LT S}}{2{,}200\ \text{lb S}}$$

$$= \mathbf{0.02}\ \frac{\textbf{LT S}}{\textbf{day}}$$

Average Daily Sulfur Emissions from Refinery Fuel Gas and SCOTs

	Flow, MMscf/day	Sulfur Concentration H_2S, ppmvd	Sulfur Concentration COS, ppmvd	Total S LT/D
Refinery fuel gas	58	10		0.02
Flexigas	180	33	44	0.5
Total Refinery Fuel Gas				**0.6**
Total Sulfur Recovery Units (SCOTs)				**0.1**
54% of SCOTs S is from Refinery Fuel Gas				0.06
46% of SCOTs S is from Sour Water Strippers				0.05

Refinery Fuel Gas Sulfur Removal and Recovery Efficiency on Refinery Wide Basis

Recovered S from refinery wide fuel gas =	122	LT/D S
Emitted S from combustion of refinery wide fuel gas =	0.6	LT/D S
Emitted S from SCOT attributed to refinery wide fuel gas =	0.06	LT/D S
Total S not recovered from refinery wide fuel gas =	0.6	LT/D S
Percent total S removed and recovered from refinery wide fuel gas =	99.5%	

Calculation: Process Water Sulfur Removal and Recovery Efficiency on Refinery Wide Basis

Sulfur from Process Water to Sulfur Recovery Units =	100	LT/D S
Sour Water =	48.3	MB/D
Sour Water =	2,028,600	gallons per day
HS Stripped Water Concentration =	<1	below detection limit
Molecular weight HS =	33	
Molecular weight S =	32	
Density of water =	8.34	lbs/gallon

Sulfur Remaining in Stripped Water

Sulfur (LT/D) = 2,028,600 gallons water / day x 8.34 lbs water / gallon water x 0.0001% HS, by weight

x 32 lbs S/lb-mol / 33 lbs HS/lb-mol x LT / 2,200 lbs = 0.007 LT S / day

Process Water Sulfur Removal and Recovery Efficiency on Refinery Wide Basis

Recovered S from refinery wide process water =		100	LT/D S
S remaining in refinery wide stripped water =		0.007	LT/D S
Emitted S from SCOT attributed to refinery wide process water =		0.05	LT/D S
Total S not recovered from refinery wide process water =		0.06	LT/D S
Percent total S removed and recovered from refinery wide process water =	>	99.9%	

Calculation: Process Water Ammonia Removal Efficiency on Refinery Wide Basis

Nitrogen from Process Water to Sulfur Recovery Units =	79	LT/D N
Ammonia from Process Water to Sulfur Recovery Units =	96	LT/D NH_3
Sour Water =	48.3	MB/D
Sour Water =	2,028,600	gallons per day
NH3HS Stripped Water Concentration =	50	ppmw
Molecular weight NH_3HS =	50	
Molecular weight NH_3 =	17	
Density of water =	8.34	lbs/gallon

Ammonia in Stripped Water

Ammonia (LT/D) =

$$2{,}028{,}600 \frac{\text{gallons water}}{\text{day}} \times 8.34 \frac{\text{lbs water}}{\text{gallons water}} \times 0.005\% \ NH_3HS\text{, by weight} \times \frac{17 \text{ lbs } NH_3/\text{lb-mol}}{50 \text{ lbs } NH_3HS/\text{lb-mol}} \times \frac{\text{LT}}{2{,}200 \text{ lbs}} = 0.1 \frac{\text{LT } NH_3}{\text{day}}$$

Process Water Ammonia Removal Efficiency on Refinery Wide Basis

NH_3 from refinery wide process water destroyed in SRU =	96	LT/D S
NH_3 remaining in refinery wide stripped water =	0.1	LT/D S
Percent total NH_3 removed from refinery wide process water = >	99.9%	