H_2S Scrubbing using Hypochlorite and Caustic

Alltrust - D Shin - May 3, 2007 - Current Design

Input				Results			
Foul Air Flow		50,040	Am³/h	TDS in Blowdown		9.6%	
Temperature		35	°C	HTU_{H2S}		269	mm
Pressure		0.0	mbar	NTU_{H2S}		7.13	
Inlet H_2S Concentration		250	ppm_v	Outlet H_2S Concentration		0.20	ppm_v
	=	379	mg/Nm³		=	0.3	mg/Nm³
Inlet CO_2 Concentration		360	ppm_v	H_2S Removal Efficiency		99.9	%
	=	707	mg/Nm³	Pressure Gradient		0.3	mbar/m
Liquid Recirculation Rate		150.0	m³/h	Packing Pressure Drop		0.8	mbar
Blowdown Rate		3.00	m³/h	Demister Pressure Drop		0.4	mbar
pH in Sump		9.5		Liquid Holdup		2.6%	
Make-up NaOH Concn.		50%		Packing Volume		23.1	m³
Make-up NaOCl Concn.		12.5%		Demister Volume		4.81	m³
Tower Diameter		3500	mm	NaOCl Consumption		147.7	kg/h
Safety Factor		1.25			=	1094	L/h
Packing Type		Q-PAC		NaOH Consumption		42.2	kg/h
Packing Height		2400	mm		=	55.2	L/h
NUPAC Demister Height		500	mm	Theoretical Fan Power		1.71	kW

Air Flow Rate	44,360	Nm³/h	Cross-Section Area	9.6	m²	
=	33,013	mol/min	Gas Molecular Weight	29	g/mol	
H_2S Removed	281.0	g/min	Gas Density	1.15	kg/m³	
	8.266	mol/min	Liquid Density	1,000	kg/m³	
blowdown	1.88	m³/h	Superficial Gas Velocity	1.4	m/s	
	50	L/min	Gas Loading	5,991	kg/m²-h	
Na_2SO_4 production	1172.7	g/min	Liquid Loading	16	m³/m²-h	
$[Na_2SO_4]$	23.5	g/L	HTU_{CO2}	2384	mm	
=	0.17	mol/L	$[H^+]$	3.16E-10	mol/L	
NaOCl usage	2459.5	g/min	T	308.2	°K	
NaCl Produced & Added	3861.9	g/min	P_T	1.00	atm	
[NaCl]	77.3	g/L	**Equilibrium Constants**			
CO_2 Removed	8.94E-01	mol/min	CO_2 K_1	4.88E-07	mol/L	
$[CO_2]+[HCO_3^-]+[CO_3^=]$	1.79E-02	mol/L	CO_2 K_2	5.53E-11	mol/L	
$[CO_2]$	9.85E-06	mol/L	**Henry's Constant**		**CO_2**	
$[HCO_3^-]$	1.52E-02	mol/L	H (atm/mole fraction)		1,775	
$[CO_3^=]$	2.66E-03	mol/L	**NTU calculation**	**H_2S**	**CO_2**	
$NaHCO_3$	1.3	g/L	y_1 (mg/Nm³)	379	707	
Na_2CO_3	0.3	g/L	y_2 (mg/Nm³)	0.30	654	
free NaOH	0.001	g/L	Removal Efficiency	99.9%	7.5%	
NaOH added	701.8	g/min	$\ln(y_1-y_1^*)$		4.5	
Total Dissolved Solids	102.3	g/L	y_1^* (mg/Nm³)		619	
$[Na^+]$	1.67	equiv/L	y_2^* (mg/Nm³)		606	
Blowdown Density	1.06	g/mL	$(y-y^*)_{lm}$ (mg/Nm³)		66	
$NaHCO_3$ Saturation Index	-1.7		$x_{1,CO2}$ (mol/mol)		1.8E-07	
Na_2CO_3 Saturation Index	-4.5		Expected NTU		0.81	
NaCl Saturation Index	-1.1		Calculated NTU		0.81 ✓	
Make-up NaOH Density	1.53	g/mL	Discrepancy (×10³)		0.00000	

H_2S Scrubbing using Hypochlorite and Caustic

Alltrust - D Shin - May 3, 2007 - LANTEC Optimized

Input				Results			
Foul Air Flow		50,040	Am³/h	TDS in Blowdown		18.7%	
Temperature		35	°C	HTU_{H2S}		354	mm
Pressure		0.0	mbar	NTU_{H2S}		7.00	
Inlet H_2S Concentration		250	ppm_v	Outlet H_2S Concentration		0.23	ppm_v
	=	379	mg/Nm³		=	0.3	mg/Nm³
Inlet CO_2 Concentration		360	ppm_v	H_2S Removal Efficiency		99.9	%
	=	707	mg/Nm³	Pressure Gradient		1.3	mbar/m
Liquid Recirculation Rate		72.0	m³/h	Packing Pressure Drop		4.0	mbar
Blowdown Rate		1.44	m³/h	Demister Pressure Drop		1.7	mbar
pH in Sump		9.5		Liquid Holdup		2.8%	
Make-up NaOH Concn.		50%		Packing Volume		15.2	m³
Make-up NaOCl Concn.		12.5%		Demister Volume		2.45	m³
Tower Diameter		2500	mm	NaOCl Consumption		147.7	kg/h
Safety Factor		1.25			=	1094	L/h
Packing Type		Q-PAC		NaOH Consumption		41.0	kg/h
Packing Height		3100	mm		=	53.6	L/h
NUPAC Demister Height		500	mm	Theoretical Fan Power		7.82	kW

Air Flow Rate	44,360	Nm³/h	Cross-Section Area	4.9	m²	
=	33,013	mol/min	Gas Molecular Weight	29	g/mol	
H_2S Removed	281.0	g/min	Gas Density	1.15	kg/m³	
	8.265	mol/min	Liquid Density	1,000	kg/m³	
blowdown	1.88	m³/h	Superficial Gas Velocity	2.8	m/s	
	24	L/min	Gas Loading	11,743	kg/m²-h	
Na_2SO_4 production	1172.6	g/min	Liquid Loading	15	m³/m²-h	
$[Na_2SO_4]$	48.9	g/L	HTU_{CO2}	3138	mm	
=	0.34	mol/L	$[H^+]$	3.16E-10	mol/L	
NaOCl usage	2459.2	g/min	T	308.2	°K	
NaCl Produced & Added	3861.5	g/min	P_T	1.00	atm	
[NaCl]	160.9	g/L	**Equilibrium Constants**			
CO_2 Removed	4.62E-01	mol/min	CO_2 K_1	4.88E-07	mol/L	
$[CO_2]+[HCO_3^-]+[CO_3^=]$	1.92E-02	mol/L	CO_2 K_2	5.53E-11	mol/L	
$[CO_2]$	1.06E-05	mol/L	**Henry's Constant**		**CO_2**	
$[HCO_3^-]$	1.64E-02	mol/L	H (atm/mole fraction)		1,775	
$[CO_3^=]$	2.86E-03	mol/L	**NTU calculation**	**H_2S**	**CO_2**	
$NaHCO_3$	1.4	g/L	y_1 (mg/Nm³)	379	707	
Na_2CO_3	0.3	g/L	y_2 (mg/Nm³)	0.35	680	
free NaOH	0.001	g/L	Removal Efficiency	99.9%	3.9%	
NaOH added	681.8	g/min	$\ln(y_1-y_1^*)$		3.7	
Total Dissolved Solids	211.4	g/L	y_1^* (mg/Nm³)		665	
$[Na^+]$	3.46	equiv/L	y_2^* (mg/Nm³)		652	
Blowdown Density	1.13	g/mL	$(y-y^*)_{lm}$ (mg/Nm³)		35	
$NaHCO_3$ Saturation Index	-1.3		$x_{1,CO2}$ (mol/mol)		1.9E-07	
Na_2CO_3 Saturation Index	-3.9		Expected NTU		0.79	
NaCl Saturation Index	-0.5		Calculated NTU		0.79 ✓	
Make-up NaOH Density	1.53	g/mL	Discrepancy (×10³)		0.00000	