Scrubbing Ammonia using Sulfuric Acid

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for HEE (Intel Scrubbers DXI8142A, maximum flow, automatic blowdown)

Air Flow	40,000	acfm	$(NH_4)_2SO_4$ in Blowdown	18.7%	
Inlet NH_3 Concentration	100	ppm_v	NH_4HSO_4 in Blowdown	1.3%	
Liquid Recirculation Rate	567	gpm	H_2SO_4 in Blowdown	0.01%	
Blowdown Rate	0.38	gpm	Total Nitrogen in Blowdown	45,908	mg/L
Liquid Temperature	70	°F	TDS in Blowdown	20%	
Atmospheric Pressure	29.92	in.Hg	HTU	0.58	ft
Inlet Static Pressure	0.0	in.WC	NTU	6.92	
pH in Sump	3.0		Outlet NH_3 Concentration	0.1	ppm_v
Make-up H_2SO_4 Concn.	96%		Removal Efficiency	99.9%	
Tower Diameter	10.2	ft (9 ft × 9 ft)	Pressure Gradient	0.13	in.WC/ft
Packing Height	5.0	ft	Packing Pressure Drop	0.6	in.WC
Safety Factor	1.25		Liquid Holdup	3.0%	
Packing Volume	405	ft^3	Liquid Residence Time	9	sec
Packing Type	Q-PAC		H_2SO_4 Consumption	32	lb/h
Theoretical Fan Power	4.0	hp		2.1	gal/h

Air Flow Rate	40,000	scfm	Cross-Section Area	81	ft^2
=	103.4	lbmol/min	Gas Molecular Weight	29	lb/lbmol
NH_3 Removed	0.010	lbmol/min	Gas Density	0.075	lb/ft^3
	0.18	lb/min	Liquid Density	9.29	lb/gal
	4.7	mol/min	Superficial Gas Velocity	494	ft/min
blowdown	23	gal/h	Gas Loading	2,226	$lb/h\text{-}ft^2$
	1.4	L/min	Liquid Loading	3,901	$lb/h\text{-}ft^2$
Maximum NH_3-N	4.39%		T	294.3	K
NH_3-N	4.12%	✓	P_T	1.00	atm
=	3.28	mol/L	**Equilibrium Constants**		
Total Dissolved Solids	223	g/L	H_2SO_4 K_2	1.20E-02	mol/L
=	20.0%		NH_3 K_b	1.67E-05	mol/L
H_2SO_4 Added	167	g/L	K_w	7.16E-15	mol^2/L^2
Blowdown Density	1.11	g/mL	NH_3 Henry's Law Constant	1.0	atm-mol/mol
$(NH_4)_2SO_4$ Satn. Index	-1.2		**Packed Section**	**top**	**bottom**
Make-up H_2SO_4 Density	1.86	g/mL	pH	2.99	3.00
NTU	6.92		$[H^+]$	1.03E-03	1.00E-03
$\Delta NTU \times 10^3$	0.00000	✓	$[SO_4^=]$ (mol/L)	1.5713	1.5745
$\Delta[H_xSO_4]^*10^3$	0.00000	mmol/L ✓	$[HSO_4^-]$ (mol/L)	0.1343	0.1312
Acid Exhaustion per Pass	2%		$[NH_4^+]$ (mol/L)	3.2770	3.2791
Satd. $y_{1,H2O}$	2.45%		$[NH_3]$ (mol/L)	1.37E-06	1.41E-06
y^*_{H2O}	2.31%		$[NH_3]$ (mol/mol)	2.47E-08	2.54E-08
$y_{2,H2O}$	2.31%		y* (ppm_v)	0.024	0.024
H_2O Absorbed	0.145	lbmol/min			
$\Delta NH_3\text{-}N \times 10^3$	-2.7315				