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EQUILIBRIUM AMMONIUM CONCENTRATION IN SLURRY MIX EVAPORATOR CONDENSATE TANK (SMECT) WITH AMMONIA SCRUBBERS (U)

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Equilibrium Ammonium Concentration in Slurry Mix Evaporator Condensate Tank (SMECT) with Ammonia Scrubbers (U)

INTRODUCTION:

The original calculation [1] of the maximum batch ammonium concentration did not take into account the chemical neutralization in the Recycle Collection Tank (RCT). During design reviews it was determined that in all cases the RCT scrub solution could not be routed to the RCT. During transfers to the tank farm (estimated ten hour cycle), the ammonia evolved from the RCT is scrubbed by the RCT scrubber and the ammonia scrub water must be returned to the SMECT. The result of this is an increased steady state concentration of ammonium in the SMECT water used for the ammonia scrubbers. The maximum ammonium concentration is necessary for the sizing of the ammonia scrubbers for the Sludge Receipt and Adjustment Tank (SRAT), Slurry Mix Evaporator (SME), and RCT. Figure 1 is a simplified schematic of the ammonia scrubbers.

SUMMARY:

The equilibrium ammonium concentration in the SMECT is 0.0015 mole fraction ammonium. This water is chemically adjusted to pH 3.0 and used for the scrub solution in the ammonia scrubbers. A mass balance (Table 1) was completed using the volume transfers made by the batch model for the SMECT and RCT [2]. The ammonia content of the Precipitate Hydrolysis Aqueous (PHA) was determined experimentally in IDMS using the PHA produced using the HAN process (higher in ammonium than PHA produced using the late wash process).

The higher equilibrium ammonium concentration will be controlled by the used of excess acid in the SMECT to lower the pH to 3.0. The effect of the higher ammonium

concentration is minimal since the ammonia concentration is controlled by starting with a pH of 3.0. A model of the scrubber ammonia profile was estimated using the OLI ELECTROCHEM version 9.0 electrolytic chemical modeling program [3]. A summary of the data for a starting point of pH 3.0 and ammonium concentration of 0.0015 is summarized in Figures 2 and 3. These figures are a replacement for Figures 3 and 4 in the original document [1]. The effect on the design of the scrubbers should be minimal and can be controlled by a lower starting pH than the 3.0 that was specified to minimize corrosion problems.

FIGURE 1
AMMONIA SCRUBBER SCHEMATIC

References

1. J. T. Carter, D. P. Lambert, A. S. Choi, WSRC-TR-92-296, Revised Basis and Calculation Methods for the DWPF Ammonia Scrubbers (U), June 20, 1992.
2. R. E. Edwards, WSRC-92-0159, Assessment of DWPF Batch Cycle Times Using the DWPF Batch Simulation Program (U), March 16, 1992.
3. A. S. Choi, Ammonia scrubber model using OLI ELECTROCHEM Version 9.0, September 22, 1992.

Figure 2
Ammonia/Ammonium Vapor-Liquid Equilibri
SMECT starting pH = 3.0

Figure 3
Ammonia/Ammonium Vapor-Liquid Equilibri
SMECT starting pH = 3.0

TABLE 1
AMMONIA MASS BALANCE WITH RCT RECYCLE

Step #	Batch Time	Step Description	SMECT		RCT	
			Volume Change	NH ₃ evolution moles NH ₃ [NH ₃]	Volume Change	moles NH ₃ [NH ₃]
0		Start	1500	451	1500	195
1	28:5	Receive SRAT 1 st PHA				
2	28:19	Receive OGCT	4680	271	4169	5669
3	28:20	Transfer SMECT	-3931		3931	654
4	29:5	Receive SRAT 2nd PHA	4680	814		77
5	29:7	Transfer to Tank Farm		164	-8100	0
6	29:8	Receive DWTT			5162	0
7	29:19	Transfer to Tank Farm		77	-5162	0
8	30:0	Receive OGCT			4136	5635
9	30:1	Transfer SMECT	-3965		3965	754
10	30:11	Transfer to Tank Farm		164	-8100	92
11	30:23	Receive SME	1998	476		
12	31:4	Receive SME	1999	476		
13	31:5	Receive OGCT			4146	5645
14	31:7	Transfer SMECT	-3955		3955	1046
15	31:18	Transfer to Tank Farm		164	-8100	138
16	31:23	Receive SME	57			
17	32:5	Receive SRAT	1809			
18	32:8	Receive SRAT 1st PHA	4681	271		
19	32:9	Receive OGCT			4160	5661
20	32:17	Transfer SMECT	-3940		3940	617
21	33:4	Transfer to Tank Farm		164	-8100	71
22	33:8	Receive SRAT 2nd PHA	4680	814		
23	33:14	Receive OGCT			4142	5642
24	33:17	Transfer SMECT	-3959		3959	709
25	34:3	Transfer to Tank Farm		164	-8100	85
26	34:5	Transfer SMECT	-4833		4833	934
27	34:6	Receive DWTT			3267	9601
28	34:16	Transfer to Tank Farm		164	-8100	120
29	34:19	Receive OGCT			4181	5682
30	35:3	Receive SME	1998	476		
31	35:7	Receive SME	1998	476		
32	36:0	Receive OGCT			3919	9601
33	36:2	Receive SME	57			
34	36:9	Receive SRAT	1809			
35	36:10	Transfer to Tank Farm		120	-8100	0
36	36:12	Transfer SMECT	-5861		5861	1121
37	36:23	Transfer to Tank Farm		164	-5861	195

END

**DATE
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