



History of Al Dissolution at SRS



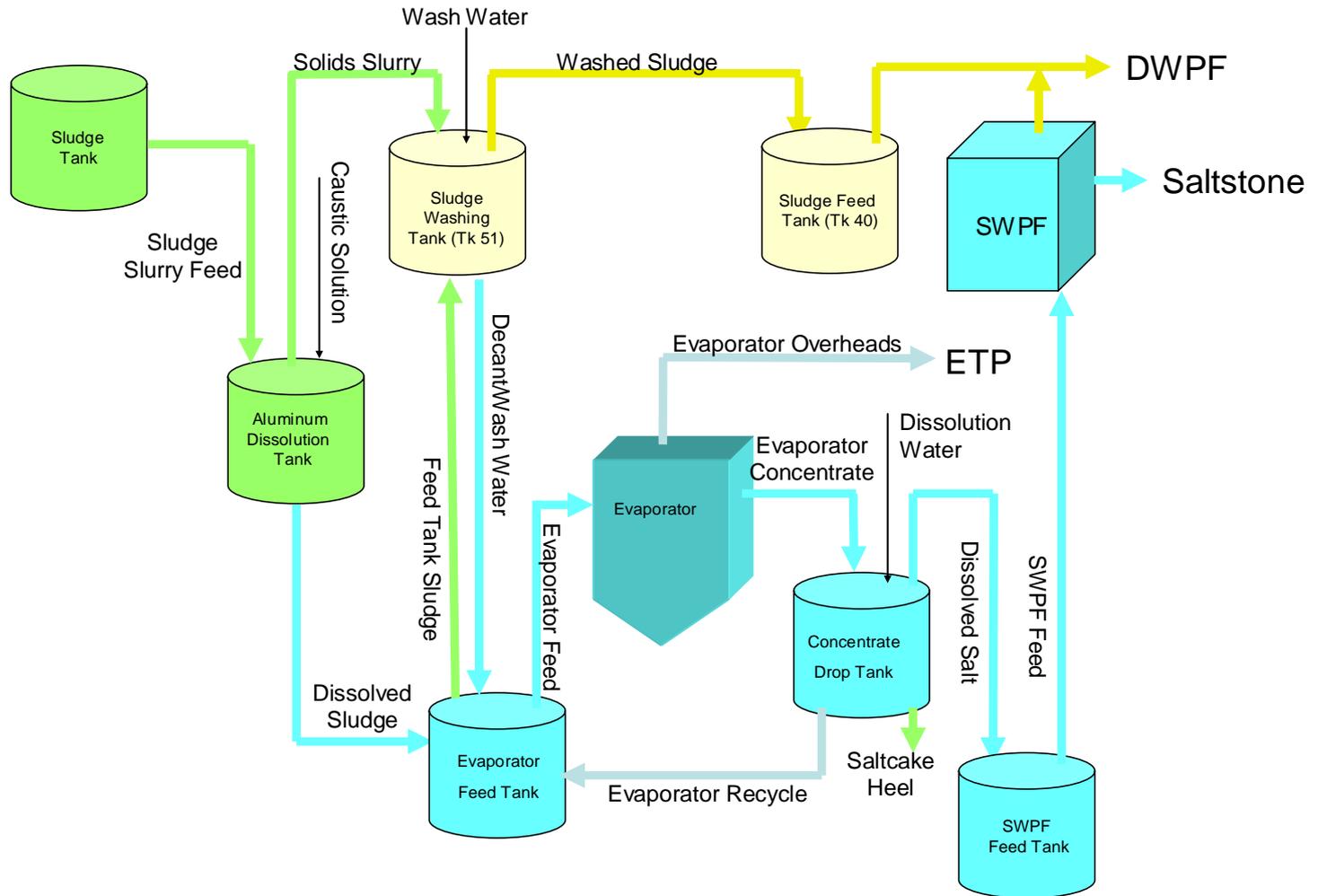
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Overview

- 1980's process concept
- Laboratory test data
- 1982 Full-Scale Demonstration
- 2000's process concept

1980's Process Concept



Laboratory Test Data

- 6/30/80 Tank 15 DPST-80-361
 - 5 M NaOH 16:1 OH:Al ratio boiling volume reduced 8.1 l to 3.3 l
 - 3 M NaOH 3:1 OH:Al ratio boiling volume reduced 4.5 l to 4.0 l
- 3/17/81 Tank 11 DPST-81-328
 - 5 M NaOH 16:1 OH:Al ratio 100°C for 1 & 6 hours 14% and ~65% dissolved respectively
- 3/23/82 Synthetic Tank 11 and 15 DP-1617

Laboratory Test Data

- 8/19/82 Tank 15 DPST-82-788
 - 3 M NaOH 6.5:1 OH:Al ratio 80°C for <24 hours ~95% dissolved
 - 6 M NaOH 13.5:1 OH:Al ratio 80°C for <24 hours ~95% dissolved
 - Fe, Hg, Mn did not appear to dissolve

- 3/12/04 Tanks 11 and 12 (archived 8 years) WSRC-TR-2004-00180
 - Tank 12: 3 M NaOH 4.6:1 OH:Al ratio 86°C for 240 hours >95% dissolved
 - Tank 11: 3 M NaOH 4.6:1 OH:Al ratio 86°C for 48 hours >95% dissolved
 - Identified 15% of the Al is in solid solution with Fe and Mn compounds
 - Adding fluoride and phosphate did not improve dissolution

Small-Scale Synthetic Tanks 11 and 15 Waste

NaOH (M)	OH:Al	Temp (°C)	Time (hrs)	% Dissolved
5	4	65	16	~100% (gibbsite)
5	4	86	2	~100% (gibbsite)
3.1	2.8	70	120	~74% (74% gibbsite 26% boehmite)
3.1	2.8	86	6	~74% (74% gibbsite 26% boehmite)
5	16	107	50	~80% (boehmite)
5	8	85	130	~75% (boehmite)
5	4	85	120	~50% (20% gibbsite 80% boehmite)
5	8	85	120	~65% (20% gibbsite 80% boehmite)
5	12	85	120	~65% (20% gibbsite 80% boehmite)
5	8	85	130	~75% (boehmite)
8	8	85	100	~95% (boehmite)

Large-Scale Synthetic Tanks 11 and 15 Waste

NaOH (M)	OH:Al	Temp (°C)	Time (hrs)	% Dissolved
3.5	3.6	80	<24	~81% (79% gibbsite 21% boehmite)
6.3	8.5	90	168	~83% (24% gibbsite 76% boehmite)

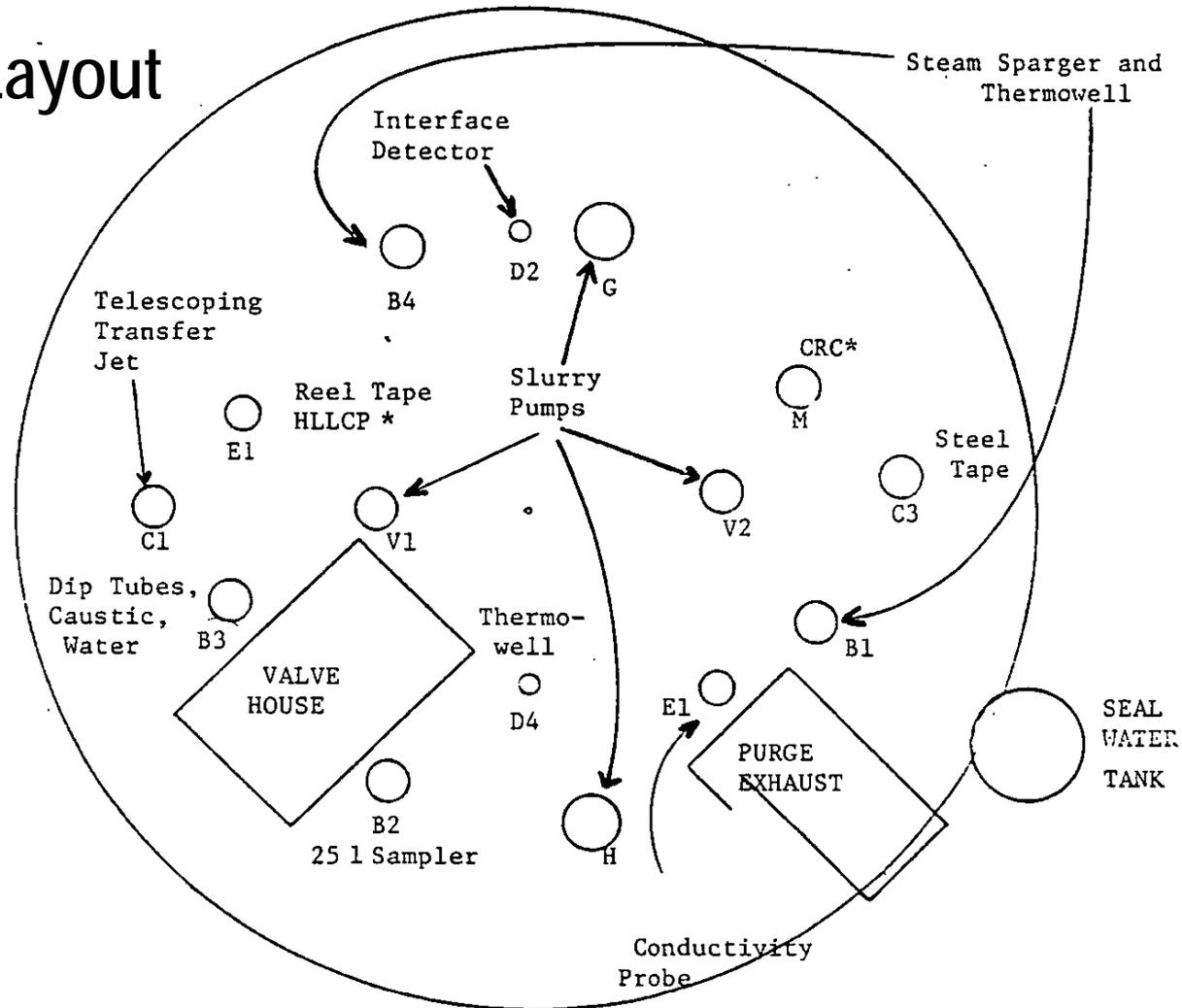
- Gibbsite dissolved in first hour of second test

1982 Full-Scale Demonstration

- Process Plan
 - Slurry Tank 15 sludge
 - Transfer 704 kgal with ~4.7wt% insoluble solids to Tank 42
 - Settle
 - Decant 640 kgal supernate to Tank 43
 - Add 104 kgal of 50% NaOH in 21 days and >20 trucks
 - Add 118 kgal Tank 24 dissolved salt solution
 - Agitate and heat for 5 days at 83 – 85°C
 - Settle and decant 429 kgal to Tank 43
 - Wash 3 times

1982 Full-Scale Demonstration

- Tank 42 Layout



1982 Full-Scale Demonstration

- Measured
 - Flammable vapor concentration
 - Sludge-supernate interface
 - Tank vibration
 - Pump performance
 - Airborne activity
 - Numerous waste samples
 - Process performance
 - Fate of nuclides

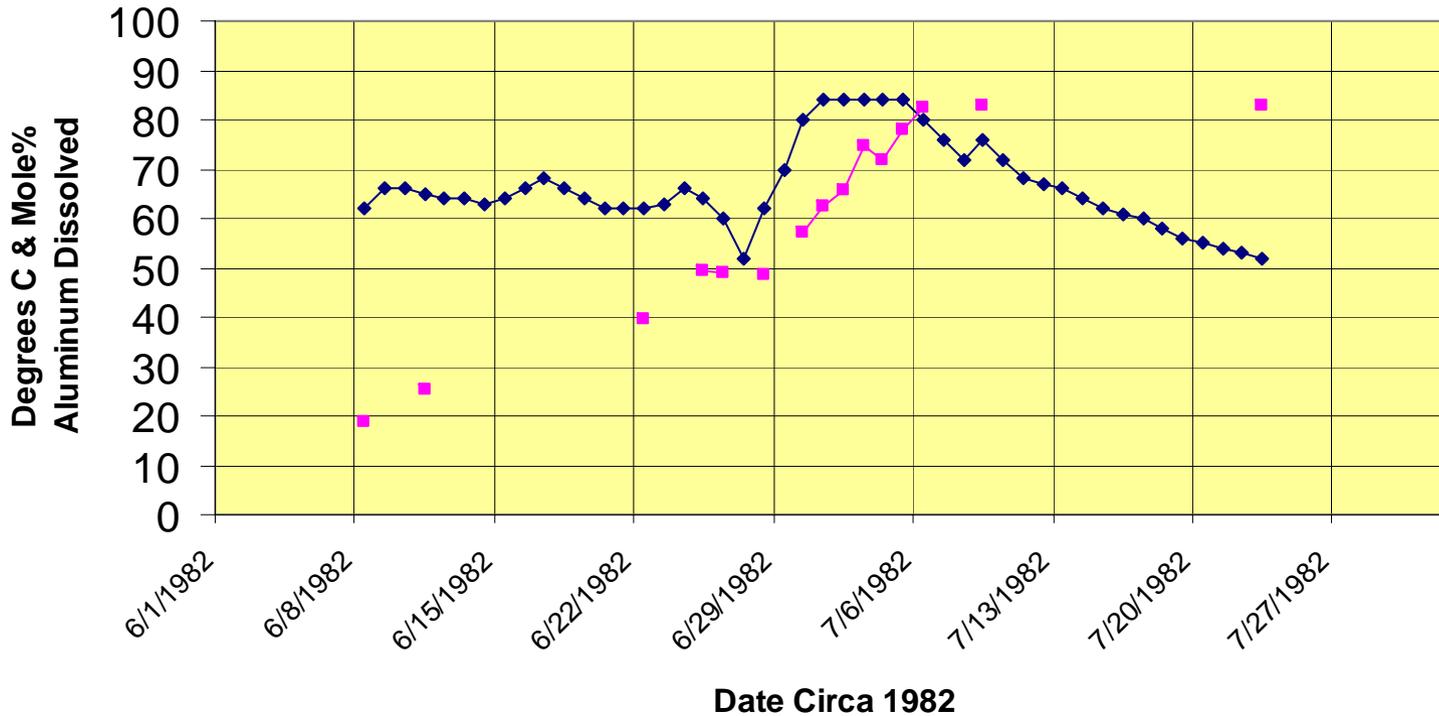
1982 Full-Scale Demonstration

- Results

- 79% of aluminum removed from sludge
- 2,975 kgal of Al-rich decant sent to Tank 43
- 775 kgal pump seal water leaked into Tank 42
 - 190 kgal during dissolution
- Cooling coils moved during slurry pump operation

1982 Full-Scale Demonstration

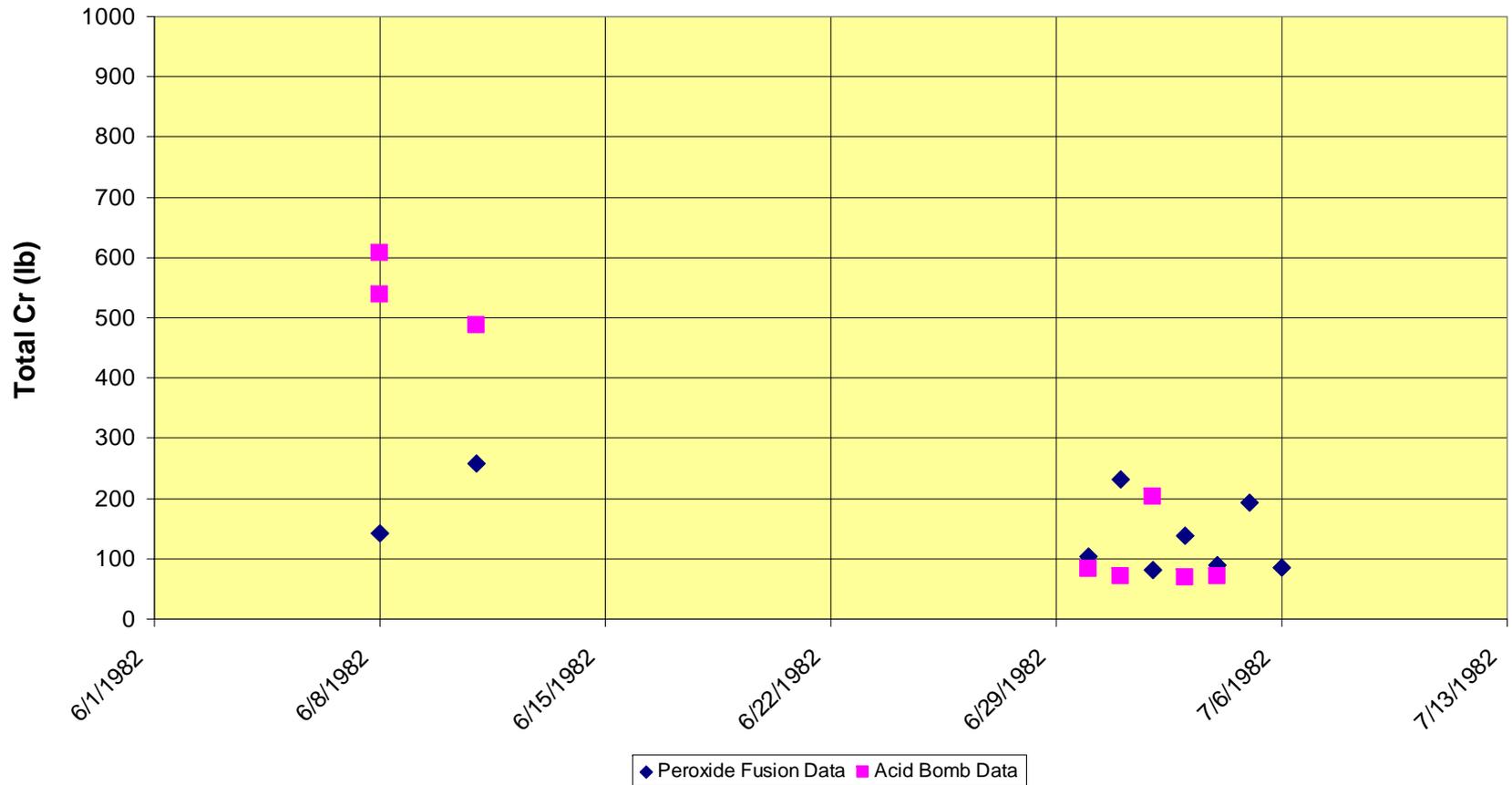
Full-scale In-tank Demonstration (1982)



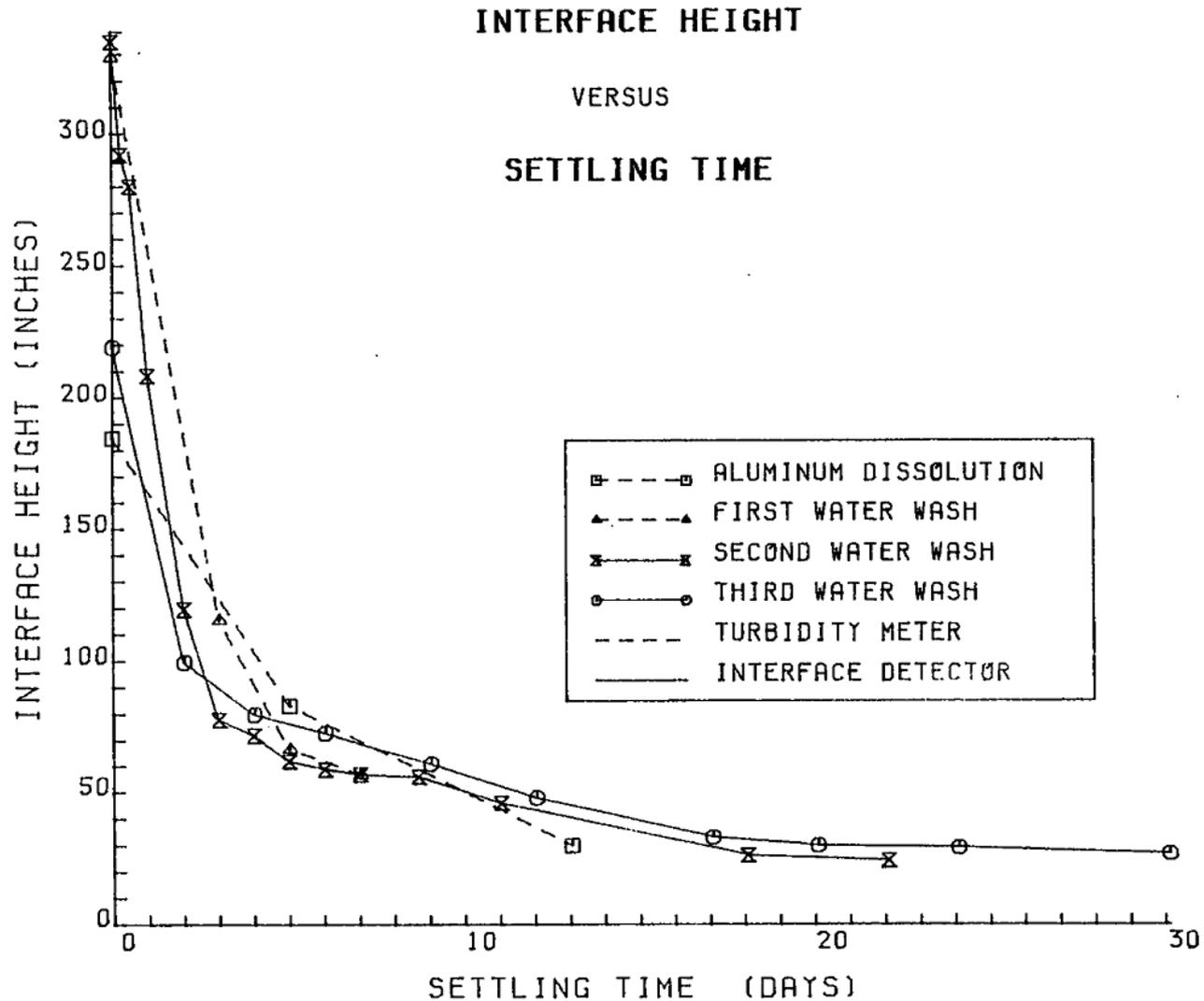
Results indicate that all gibbsite dissolved at <75°C and some boehmite dissolved at 85°C at 3M OH

1982 Full-Scale Demonstration

Insoluble Cr in Sludge Slurry



1982 Full-Scale Demonstration



1982 Full-Scale Demonstration

	Before Dissolution	After Dissolution	After Washing
wt% insoluble	4.0	2.1	4.8
OH ⁻ (M)	3.6	3.0	0.004
CO ₃ ²⁻ (M)	0.10	0.094	0.034
NO ₃ ⁻ (M)	1.3	1.17	0.0068
NO ₂ ⁻ (M)	0.28	0.25	0.021
SO ₄ ²⁻ (M)	0.060	0.050	0.0009
Al (M)	0.52	0.70	0.0041
Al wt% solids	24.9	14.1	20.6

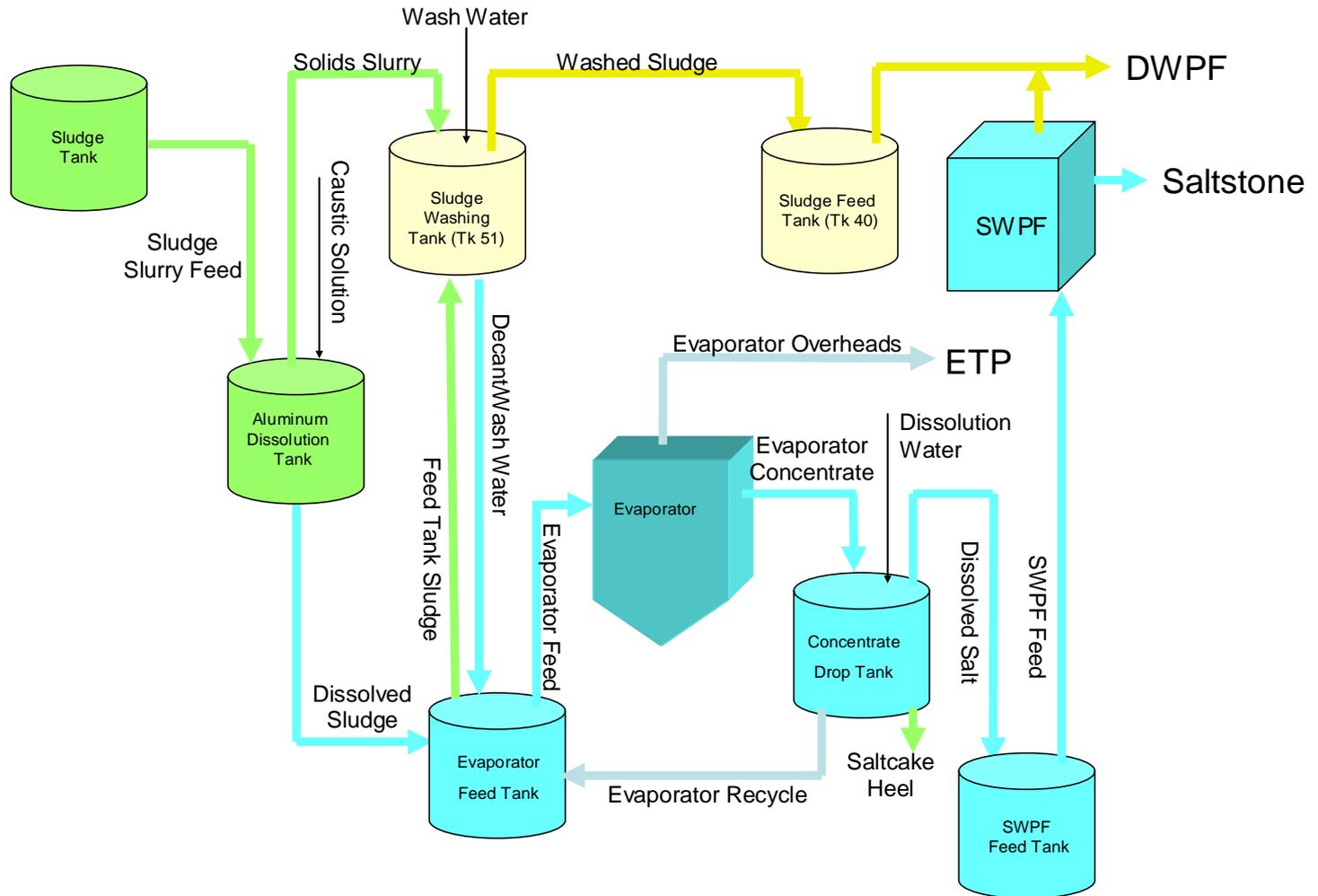
Process Conditions for Gibbsite Dissolution

	From Simulant Tests	1984 Proposed Conditions	1999 Proposed Conditions
Final [OH-] (M)	3-3.5	3 or 4*	3
Initial molar ratio OH/Al	3-3.5	3	3
Temperature (C)	80-85	80-90	85
Time at temperature (days)	3-4	Not listed	3
Steam usage (lb/hr)	-	6600	-
Heat up rate (C/hr)	-	0.5	-
Steam usage to maintain temperature (lb/hr)		1000	

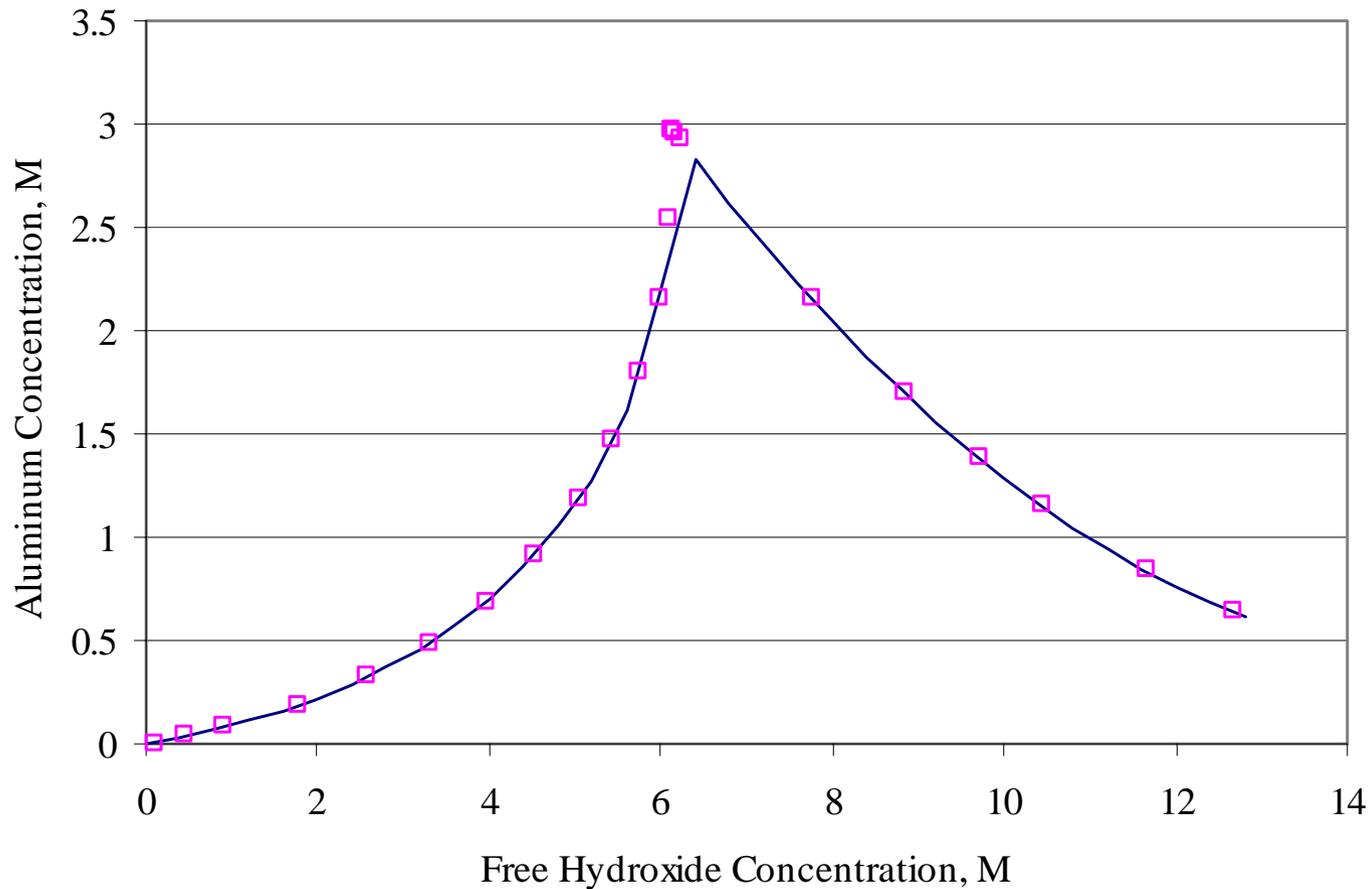
Process Conditions for Boehmite Dissolution

	From Simulant Tests	1984 Proposed Conditions	1999 Proposed Conditions
Final [OH ⁻] (M)	5.5-6	6	6
Initial molar ratio OH/Al	7.8-8.2	Not listed	6
Temperature (C)	85-90	80-90	85
Time at temperature (days)	5-6	Not listed	5
Steam usage (lb/hr)	-	6600	-
Heat up rate (C/hr)	-	0.5	-
Steam usage to maintain temperature (lb/hr)		1000	

1980's Process Concept



Approximation of Aluminum Solubility at 30°C



— Function Estimate □ OLI Precipitation Point Predictions

2000's Preliminary Flowsheet

