Les Mines Selbaie
Zinc Removal from Pit Lake

Laboratory
Limnocorrals
Batch Pit Treatment
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Selbaie Problem (2005)

- 22 Mm$^3$ of water contained in a pit lake (closed in 2004)
- Due to deposition of contaminated wastes in the pit, 10 mg/L Zn were contained in the pit lake water
- Eventual plan is to overflow clean water from the lake when full (38 Mm$^3$)
- Must meet 0.5 mg/L Zn and non-toxic
Bench Tests

• Designed to simulate scenarios:
  – Simple lime addition
  – Ferric sulphate addition
  – Mixing with other sources prior to liming
  – Red Mud addition (aluminium refinery waste)

• Only lime addition discussed in detail as it was the chosen method
Metal Precipitation
Lime Addition Tests
Lime Addition Tests
Straight Lime Addition

Results from Bench Tests

[Graph showing pH on the x-axis and Total Zn Concentration (mg/L) on the y-axis. The graph includes data points at pH values of 8.5, 9, 9.5, 10, 10.5, 11, and 11.5, with corresponding Zn concentrations.]
Straight Lime Addition

Lime Consumption Results from Bench Tests
Straight Lime Addition

- pH 10.0
  - Total Zn about 0.17 mg/L, lime consumption 0.06 mg/L (use 0.08 g/L to be conservative)
  - Chosen as Benchmark test for straight lime addition
Limnocorrals

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Limnocorals

1. pH 10.7 at surface
2. Recirc. – suction at 7.5 m depth
3. Recirc. – injection at 9 m depth
4. Control
5. pH 9.5 at surface – Red Mud addition
6. pH 9.5 at surface – biological test
Limnocorrals
Recirculation Test
Initial Treatment Results

Limno 1

- pH vs. Depth (m)
- Temperature (deg C) vs. Depth (m)
- Total Zn Concentration (mg/L) vs. Depth (m)
Limnocorral Results

- Treatment to pH 10 or more works as evidenced by 2 limnocorrals
- Treatment to pH 9.5 is insufficient
- Thermocline presents a barrier to treatment
- Injection at depth does not work in a limnocorral with an open bottom – this is not a treatment conclusion, it is a test design flaw
**Limnocorral Conclusions**

- You cannot treat and release only one layer of the pit as the thermocline presents a barrier to mixing
- Setpoint pH of 10 confirmed
Pit Treatment

- Started September 14th, ended November 5th 2005
- 2000 tonnes of quicklime injected
- pH increased to near 10 (likely higher – post treatment profiling completed late)
- Zn concentrations taken from ~10 mg/L to less than 0.2 mg/L
Pit Treatment
Cross-section

- Treated Water Discharge
- Pump barge
- Lime slaking and storage
Pit Treatment
Plan View

- Lime slaking and storage
- Main Pit
- Pump Barges
- Discharge Raft North
- Discharge Raft South
- ‘D’ Pit
- Pit Lake Contour in 2005
Portable Slaker & Storage Tank
Pump barge & HDPE Pipes
Steel Pipes Installation
Diffuser Raft Location
Pit Profile Locations

- Sampling locations

Discharge Rafts
Pumps barges
Treatment Plant
Fosse D
Sampling Raft

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Main Pit Profiles

Pit Profiles

- Last profile 10 days before end of treatment
- Last measured temperature without significant gradient (7.25 to 7.19 deg. C)
Limno Zn Profiles
- Zn Concentrations below 0.2 mg/L target at all depths before end of treatment
Pit pH Profiles After Treatment

2006

Post-Treatment
- Pit lake pH slowly decreasing despite significant added alkalinity
- Variability at surface due to liming runoff
- Thermal stratification in summer, mixing in fall
Average pH after Treatment
2005-2006

Post-Treatment
- Average pH decreasing steadily
- Greater decrease between July and October could be due to 3-week plant shutdown
- Equilibrium pH expected to be 7.5
Pit Zn Profiles after Treatment 2006

Pit Zn Profiles
- Even though pH is decreasing, Zn load still low
- Over-liming runoff helping to maintain low Zn at surface
Average Zn Concentrations after Treatment

Pit Zn Concentrations
- Recent results show increasing trend
- New surface liming system may compensate particularly in spring 2007
Pit Treatment

- pH increased in line with predictions
- Zn and Cd treatment met predictions
- 2000 t CaO was a good target
- Lake water passed toxicity testing
- Pit Treatment System a Success!!
- Maintaining high pH and low Zn concentrations remaining challenge