Challenges in Water Treatment

14th Annual BC MEND Workshop
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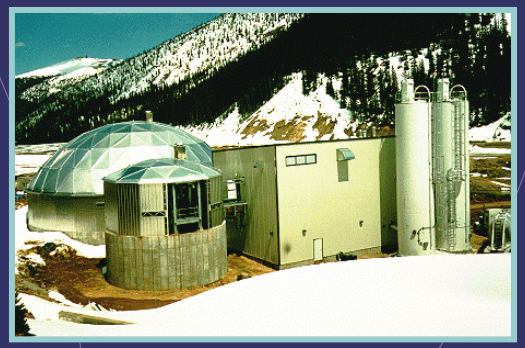
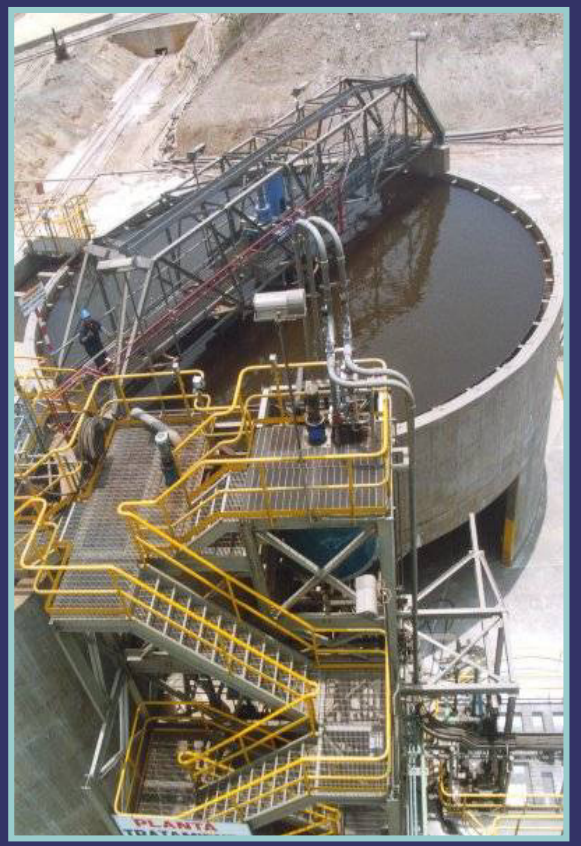


Past Disposal Practices

Current and Future Problems

AMEC Water Treatment Experience

- 16 WTPs constructed including 8 HDS plants in last 10 years
- Core process and study group in Vancouver dedicated to Water Treatment but supplied with the required disciplines to provide full engineering design and construction support to AMEC offices on a worldwide basis
- Full range of process technologies and experience in meeting low environmental limits
- Design and construction experience for harsh climates, remote locations and high elevation



Experience?

Study, design, construction, commissioning, start-up and trouble-shooting water treatment plants including:

- Cajamarquilla, Colquirica and Kingsmill in Peru
- Alumbrera, Aqua Rica and Profertil Bahia Blanc in Argentina
- Geco/Willroy, Montcalm and Totten in Ontario
- Equity, Britannia, Eskay Creek, Vancouver Wharves and Nickel Plate in British Columbia
- Gilt Edge in South Dakota
- Pogo, Pebble and Donlin in Alaska
- CEZinc Valleyfield and Norbec in Quebec
- Snap Lake and Gahcho Kue in the NWT
- Henderson/URAD in Colorado
- Confidential in California

What are the Challenges?

- Water Management
  - Collection and storage – handling peaks
- Remote Process Control
  - Design for unattended operation
- Mechanical Reliability
  - Equipment selection – proven in application
  - Backups and redundancy
  - Contingency plans for upset conditions
- Sludge Disposal
  - Forming stable precipitates – e.g. Mn and Fe co-precipitates
  - Complying with Regulations
  - Finding long-term storage locations

What are the Challenges?

- Gypsum Scale
  - Selecting optimum conditions – sludge density, pH, flocculants
  - Designing for scale removal
  - Limitations on Filtration
- Effluent Criteria
  - Lower standards moving towards Ambient at End-of-Pipe
  - Need for lower suspended solids levels
  - Sulfate and TDS removal
  - Demands for low Se levels
  - Disconnect between permitting and engineering

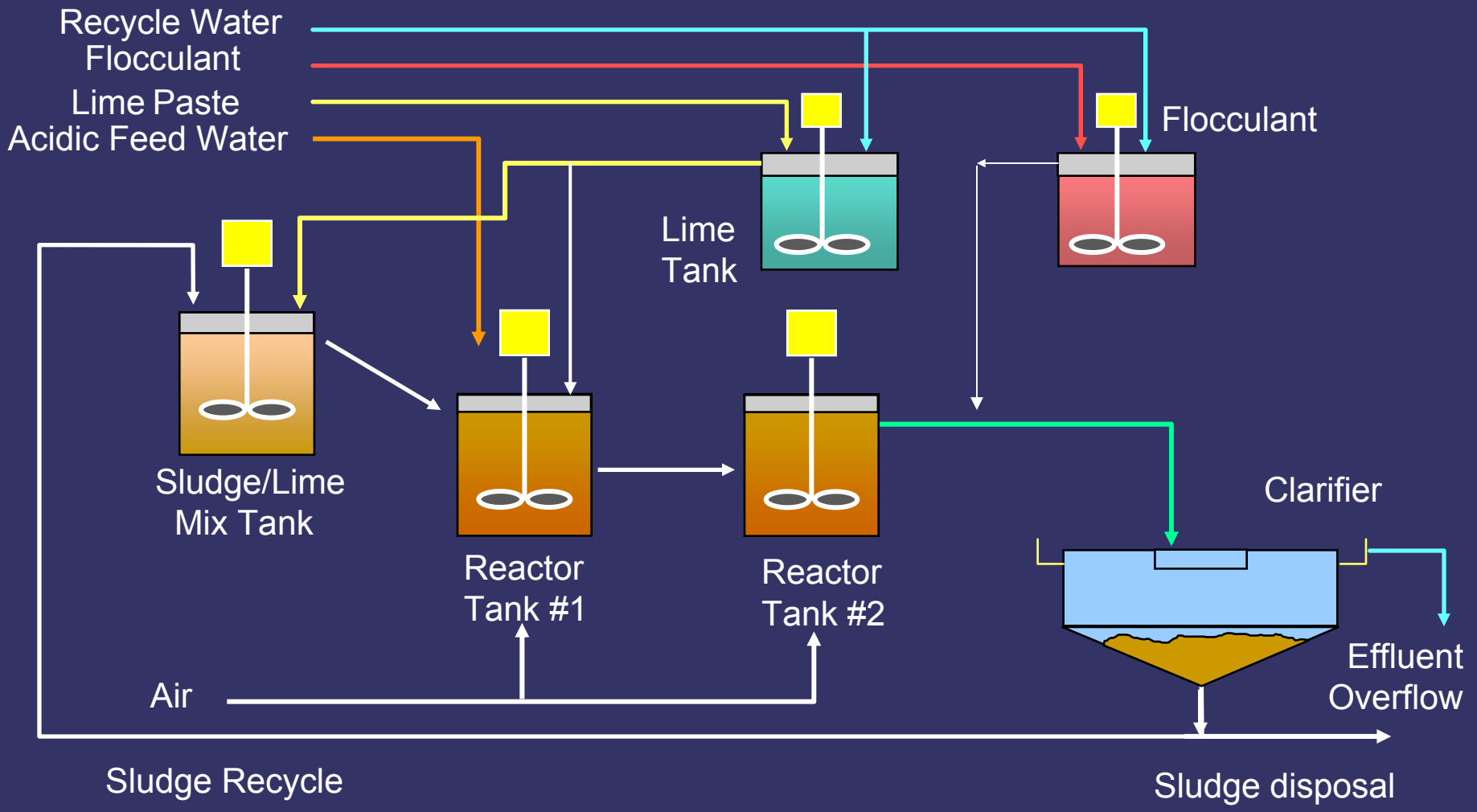
What are the Challenges?

- Costs
  - Low conceptual level capital and operating cost estimates
  - Clients cost expectations
  - CPI increased 30% between Jan 2002 and Jan 2007
  - Escalating costs for materials – steel, concrete
  - Availability of skilled labour
  - High labour rates
- Operation
  - Remote Sites
  - Lack of Trained Operators
  - Technical Supervision

What are the Challenges for Treatment Chemistry?

- Metals
  - Iron and Manganese
  - Copper, Zinc, Nickel
  - Lead, Cadmium, Silver, Mercury
- Non Metals
  - Arsenic, Antimony
  - Molybdenum
  - Selenium
- Major Anions
  - Sulphate
  - Chloride
  - Ammonia
- Suspended Solids

HDS - Process Flow Diagram



Geco-Willroy, Ontario

Project

- EPCM and commissioning of a large HDS water treatment plant
- Design flow - 930 m3/h with 70m clarifier and three 9m x 13m reactor tanks

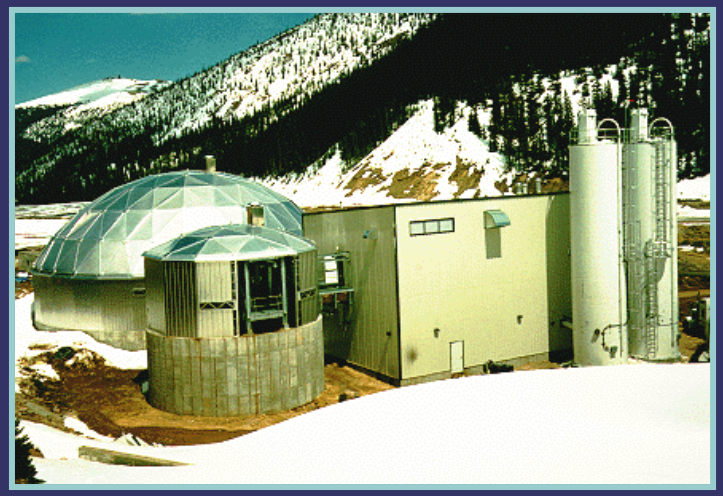
Challenges

- Design and construct plus Final commissioning and December Start-up
- Designed water diversion and collection structures and improvements, along with new pumping stations
- Design sludge disposal system - buried and above ground piping to tailings pond

GECO Operating Parameters

Parameter	Design	Permit
Design Feed Rate (m^3/h)	930	
Max. Hydraulic Load (m^3/h)	1160	
Max. Sludge Prod. (t/d d/w)	264	
Zinc (mg/L)	20	0.5
Sulphate (mg/L)	3300	
Iron (mg/L)	1000	
Copper (mg/L)	1.6	0.3
Acidity (g/L as CaCO3)	2.3	
Total Suspended Solids (mg/L)	10	15

Henderson/URAD, Colorado, USA



Project

- Treat mine water containing high concentrations of Mn and minor amounts of Zn at molybdenum mine and decommissioned uranium mine

Challenges

- Use HDS process to oxidize Mn using air
- Produce a dense sludge without a filter press that can be handled with mechanical equipment
- Comply with regulation for Mn and Zn
- Design for cold weather and long operating period

Henderson/URAD

Design Criteria

- Flows 3000 gpm
- HDS Process
  - Produces MnO_2 sludge 30-40 %
- Feed
  - Mn 200 mg/L
  - Zn 10 mg/L
- Effluent
  - Mn <1 mg/L
  - Zn <0.1 mg/L

Sludge

- Produced at over 45% solids due to presence of MnO_2
- Settles to over 65%
- Sludge removed from temporary pond on a campaign basis using mechanical equipment

Refinería de Cajamarquilla, Peru

- AMEC services - Design and construction of HDS plant to remove heavy metals from high strength refinery effluent
- High acid content (pH <2) and major concentrations of SO_4, Zn, Mn, Pb, Cd, Fe and As
- Treated water required to meet irrigation criteria
- Sludge disposal via pipeline over distance of 2 Km

Cajamarquilla

Cajamarquilla Feed and Effluent

Parameters (metals mg/L)	Feed	HDS Effluent	Final Effluent	Permit
pH	1.5	<9.5	7 to 8	<9.0
Zn	1230	0.165	0.04	3.0
Fe	450	0.012	0.02	2.0
Mn	380	0.081	0.02	0.5
Cd	10.6	0.007	0.011	0.05
Cu	8.1	0.013	0.014	0.5
Ni	0.9	0.002	0.002	
Se	0.9	0.05	0.04	0.05
Hg	0.25	0.002	0.001	0.01

Cajamarquilla Sludge Characteristics

Sulfate	–	47%	Magnesium	–	0.7%
Calcium	–	21%	Arsenic	–	0.24%
Carbonate	–	20%	Lead	–	0.04%
Zinc	–	5.5%	Cadmium	–	0.02%
Silica	–	2%	Copper	–	0.02%
Manganese	–	1.8%	Selenium	–	<0.01%
Iron	–	0.8%	Mercury	–	22 ppm

CEZinc, Valleyfield, Quebec, Canada

Project

- Design HDS plant to replace LDS system at zinc refinery
- Reduce sludge storage requirements by producing coarse, self-draining, pumpable sludge at 40+% solids which will dewater to 55+% solids in existing pond
- Design process control system to handle highly variable flows and loadings

CEZinc

Challenges

- High strength variable feed containing major amounts of Mn, SO_4 and Zn
- Process required multi-stage lime addition points and “smart” pH control system

CEZ Operating Parameters

Parameter	Design	Permit
Design Feed Rate (m^3/h)	290	
Max. Hydraulic Load (m^3/h)	500	
Max. Sludge Prod. (t/d d/w)	3.2	
Zinc (mg/L)	475	0.5
Manganese (mg/L)	142	2
Iron (mg/L)	28	0.5
Cadmium (mg/L)	6	0.1

Equity Silver, BC, Canada
Placer Dome

Challenges

- Replaced LDS plant
- EPCM services
- Complete site water management
- $10 M project
- 600 m^3/h (2600 gpm) water treatment plant – startup Dec 2004
- Pumping and placement of sludge in abandoned pit
- Designed for full automation and remote control

Equity Design Feed and Effluent

Parameters (mg/L)	Design Feed	Permit Limits (Diss)
pH	2.4	6.5 to 9.5
Acidity	13,500	
Al	650	0.5
Cu	280	0.05
Fe	2000	0.3
Zn	350	0.2
SO4	12,500	
TSS	-	50
Cd	1.2	0.01
As	2.5	0.05

Pogo Mine Water Treatment Plant, Alaska

- Process development and EPCM services for a 23 m^3/hr (100 gpm) exploration adit plant to remove heavy metals, primarily arsenic, from minewater
- EPCM of full-scale 90 m^3/hr (400 gpm) plant to treat minewater and recycled tailings pond water
- Multi-media filters and sludge press
- Hydrogen peroxide and sodium hydrosulphide to reduce dissolved metals to low levels
- Final pH adjustment using carbon dioxide

Colquijirca, Peru

Project

- Design and build simple lime neutralization plant to treat acidic seepage and stormwater from coal refuse pile at lead-zinc mine

Challenges

- Highly variable storm flows
- Low-quality lime
- Need to mitigate current ARD problems in downstream area

Colquijirca, Peru

- Constructed ball mill to grind lime and generate slurry for neutralization
- Treatment in large aerated reactor
- Sludge deposited in ponds to cover acidic tailings
- Discharge mixed with other contaminated streams to meet final effluent criteria at compliance point

Alumbrera

- Concentrate and filter effluent thickener with aeration ponds for thiosalt (BOD) and copper removal in background

Minera Alumbrera
Tucuman Filter Plant, Argentina

Project

- Design and construction of system to re-thicken pipeline concentrate and treat all process.
- Overflow forwarded for treatment and concentrate sent to filter stock tanks
- Conversion of existing ponds to provide biological treatment system to remove particulate, soluble metal and thio-salts

Norbec, Quebec, Canada

Project:

- Design and build new HDS plant to treat ARD
- Plant designed for nominal flow of 1,000 gpm with maximum capacity 3,000 gpm
- Plant designed for remote operation without full-time operator
- Design makes maximum use of used equipment from on-site mill and other locations

Norbec Feed and Effluent

Parameters (Total metals mg/L)	Feed	HDS Effluent	Permit Limits
pH	2.7	9.2	6.5 to 9.5
Zn	15	0.12	0.5
Fe	108	0.47	3
Mn	7.5	0.57	1
Cu	2.8	0.05	0.3

Current Projects
Kingsmill WTP