

2008 BLRBAC Conference

Precipitator Dust Purification (PDP) for Kraft Pulp Mill Chloride Reduction

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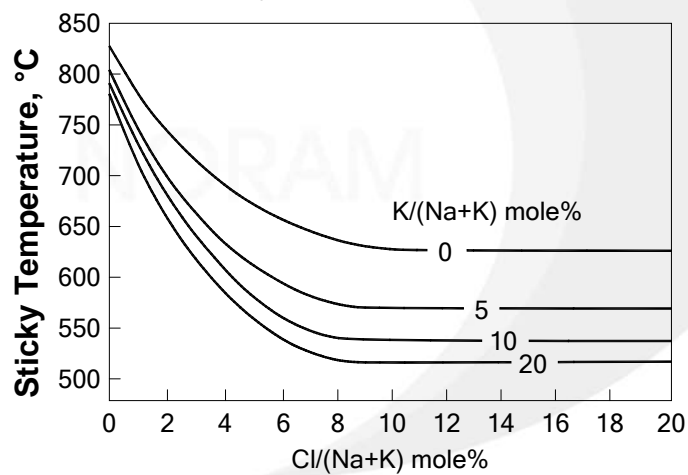
Why Reduce Chlorides?

- Chloride enters the liquor cycle with the chips and chemical make-up
- The natural purge of Cl from the recovery cycle is low so it builds up to relatively high levels
- Chloride depresses the ash's sticky temperature
 - Increased boiler fouling rates
 - Increased boiler downtime for washing
 - Increased soot blowing

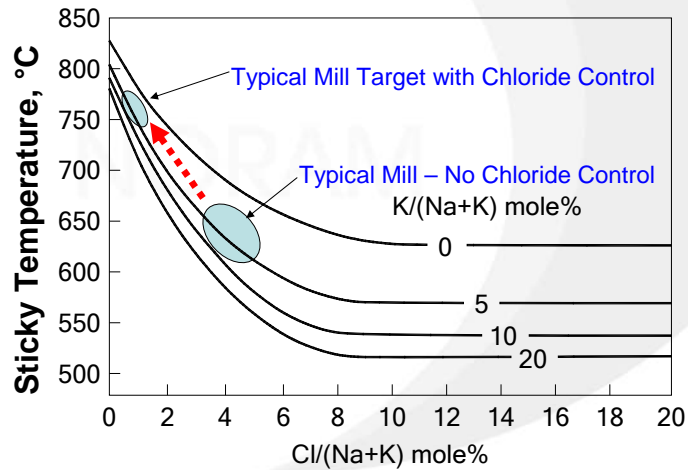
Chloride Sources

- Wood Furnish
 - Example: 2000 t/d @ 200 ppm = 0.4 t/d Cl
- Caustic make-up
 - Example: 20 t/d @ 1% = 0.2 t/d Cl
- Sulfur make-up (NaSH, sesqui, salt cake, etc.)
 - Example: 40 t/d @ 0.5% = 0.2 t/d Cl
- Mill water
 - Example: 500 gpm at 100 ppm = 0.3 t/d Cl
- Liquor sharing with other mills
 - Example: 1 truck/d at 1% Cl in DS = 0.2 t/d Cl

Effect of Deposit Composition on Sticky Temperature



Effect of Deposit Composition on Sticky Temperature



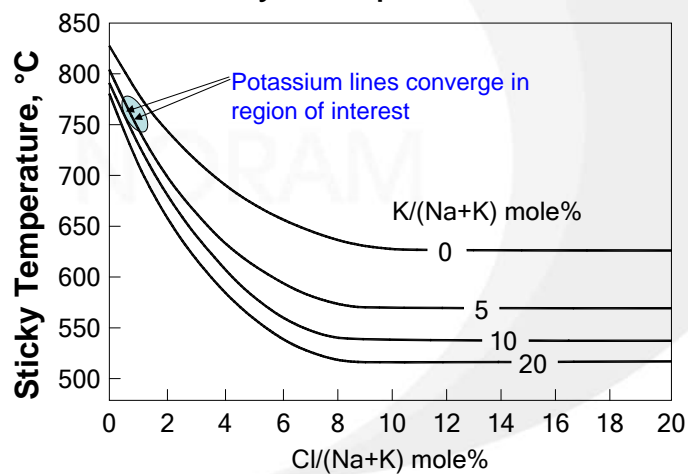
Sticky Temperature Chart

- Chart uses **mole%** (typically ~double the wt%)
- Recognize that the chart was developed for **deposit composition** which is believed to be closer to the liquor composition than the ESP ash composition where Cl & K are enriched
- That said, a lot of industry experience is based on ESP ash chloride data which tracks liquor composition
- Many mills are targeting ~1 wt% Cl in ESP ash, which corresponds to ~0.3 wt% in liquor solids or ~0.6 mole%

Sticky Temperature Chart - Potassium

- Potassium, K, is equivalent to sodium in pulping (active alkali)
- Any loss of K must be made-up as sodium (caustic)
- ***In a mill that is controlling chlorides, K makes little difference to sticky temperature*** (lines on sticky temperature chart converge)
- An equivalent sticky temperature can be reached simply by achieving slightly lower chloride levels

Effect of Deposit Composition on Sticky Temperature



ESP Ash Purging to Control Chlorides

- Many mills have begun purging ESP ash to reduce chlorides
- ESP ash is targeted for purging or treatment due to enrichment of Cl (~2 to 3x) and K (~1.5 to 2x) compared to liquors
- Typical ESP Ash Composition:
 - Sodium 25 to 30 wt%
 - Potassium 3 to 5 wt%
 - Sulfate 50 to 65 wt%
 - Carbonate 1 to 10 wt%
 - Chloride 1 to 5 wt%
 - Insolubles < 0.25 wt%

ESP Ash Purging to Control Chlorides

- Ash can be purged wet or dry, continuously or batch wise
- Purging has low capital, but high operating costs
- Chemical make-up costs for a 40 t/d ash purge are:
 - ~\$1.0 million/yr for sesqui at \$0/t & caustic at \$400/t
 - ~\$2.2 million/yr for salt cake at \$150/t & caustic at \$400/t
 - ~\$3.8 million/yr for NaSH at \$400/t & caustic at \$400/t
- Many mills find improved boiler operability (fewer cleaning cycles, etc.) more than offsets this operating cost
- *A chloride balance or ~6 month purging trial can establish benefits of low chlorides.*
- *The chemical savings compared to purging can usually justify a chloride removal system*

Cl Removal with a PDP System

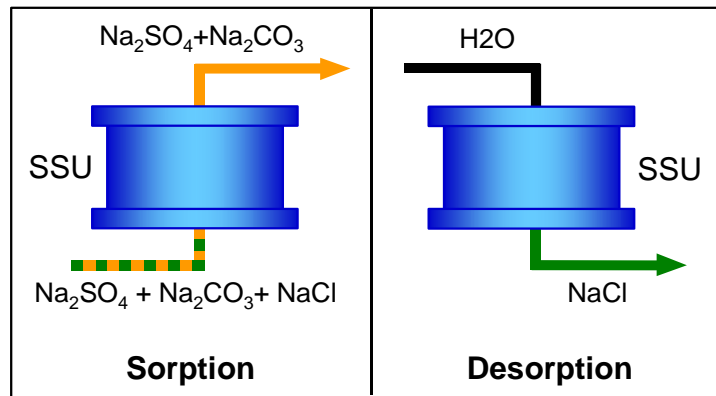
- As a mill attempts to achieve lower chloride levels it may begin to “chase its tail” due to chloride content in the make-up streams (often ~1%)
- A PDP system with high removal efficiency and low losses can achieve lower chloride levels due to reduced Cl in the make-up
- *It is useful to consider net chloride removal when evaluating competing systems*
 - *Net Cl Removal = Cl removed - Cl in make-up of losses*

PDP System - Recoflo® Separation Unit

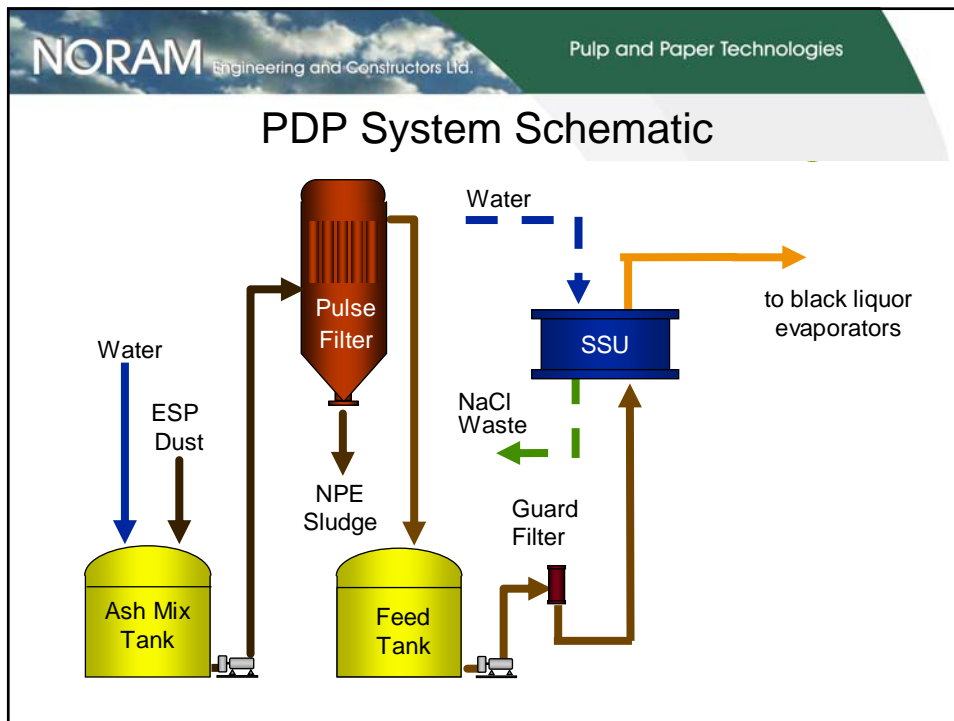


- Reciprocating flow
- Short column
- Fine-size resin beads
- Efficient separation
- Low/no dilution
- 100s of installations in a wide variety of industries

Precipitator Dust Purification



PDP System Schematic



PDP System Description

- 1. Precipitator ash is dissolved in water
- 2. Dissolved ash is filtered to remove insolubles
- 3. Dissolved ash is passed through SSU bed
 - Sodium Sulfate and Carbonate pass through resin
 - Sodium Chloride “sticks” to the resin
- 4. Purified Solution is directed to evaporators
- 5. Water is used to remove Cl & regenerate resin

PDP System Performance

- Chloride Removal, > 90%
- Carbonate Loss, < 4%
- Sulfate Loss, < 4%
- Useful Sodium Loss, < 4%
- Potassium Removal, follows Na based on mol%
- An alternative mode with higher Cl & K removal efficiencies is also available, however chemical losses are increased

PDP System Requirements (eg 50 t/d)

- ~20 gpm Mill water for dissolving ash
- Dissolved ash ~ 25 to 28 wt% (or lower if desired)
- ~35 gpm clean soft water for resin regeneration
 - evaporator condensate, softened water, RO water, etc.
- ~ 35 gpm of additional evaporator capacity (2-3%)
- ~ 21 gpm to sewer (Cl purge)

PDP System Operating Costs (eg 50 t/d)

- | | |
|--------------------------------------|---------------------|
| • Steam for evaps (\$5/t, economy 4) | \$53k/y |
| • Power (\$0.06/kWh) | \$11k/y |
| • Water (\$0.2/m ³) | \$15k/y |
| • Maintenance (resin,socks,etc.) | \$110k/y |
| • Total O & M | <\$200k/y |

PDP System Economics

- Due to low losses (<4%), chemical savings are 96% of costs of purging
- Chemical savings compared with ESP ash purging depend on mill situation but are commonly \$2 to 4 million/y
- Lower Cl levels are possible than with purging
 - Reduced boiler downtime for washing
 - Increased production
- Net operating costs of ~\$200k/y
- Simple paybacks of < 2 years common

PDP System SSU Unit



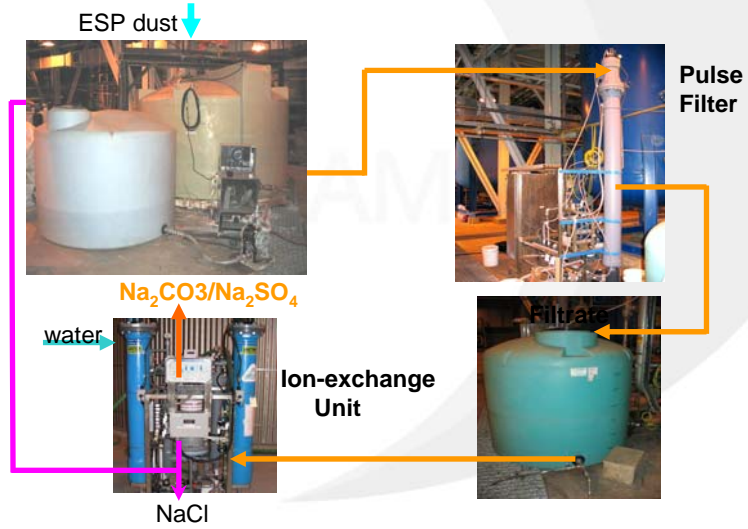
PDP – Pulse Filter Unit



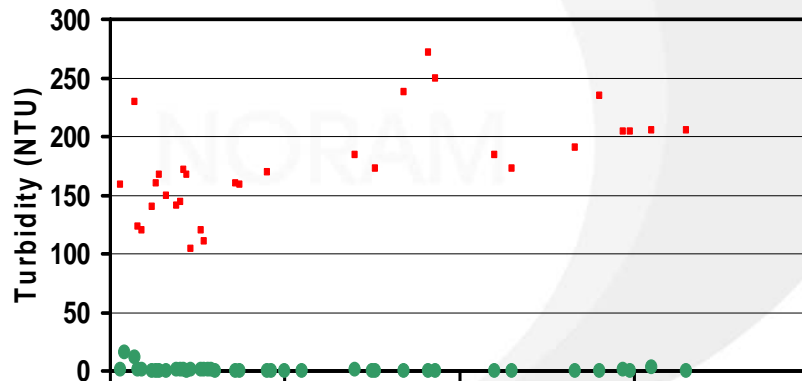
Eight Month Pilot Trial

- Conducted at Tembec, Skookumchuck
- Supporting “Eop Recycle” plans
- Representation of physical and chemical conditions:
 - Full height resin bed (24”)
 - Full size socks (2)

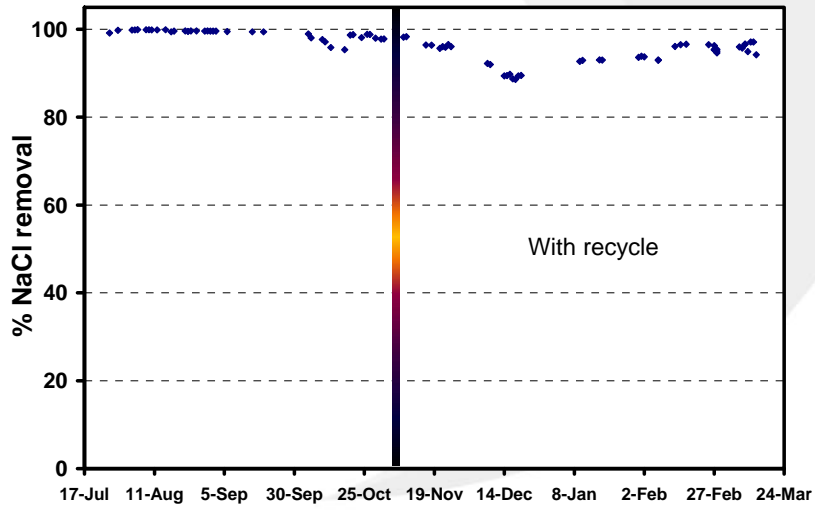
Pilot Plant Arrangement



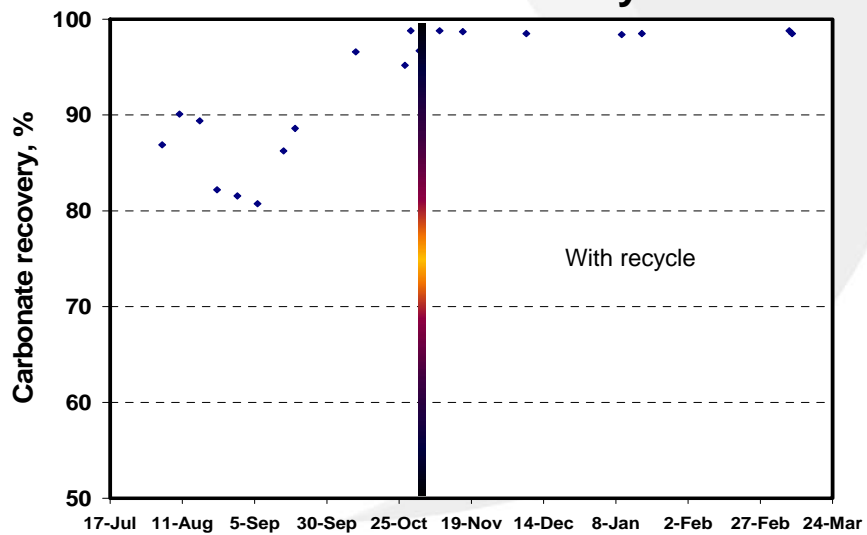
Dissolved Ash Turbidity



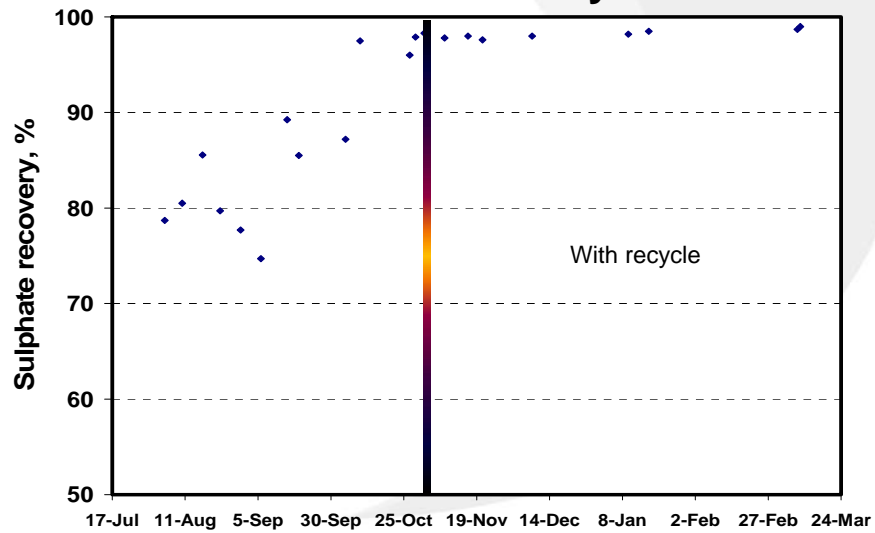
Chloride Removal



Carbonate Recovery



Sulfate Recovery



Pilot Results

- Published at 2007 International Chemical Recovery Conference
- Chloride removal >90% in recycle mode
- Carbonate and Sulfate recovery 96 to 98%
- Good filtrate turbidity (< 0.5 NTU or <1 ppm)

1st Commercial PDP Installation

- Confidential Client in US
- Delivered on time & on budget
- Recently commissioned
- Has met all of its guarantees:
 - Chloride removal
 - Sulfate recovery
 - Carbonate recovery

PDP Advantages - Construction

- Small footprint,
 - SSU installs under ESP
 - Pulse filter installs beside ESP
 - No new building required
- Low Installation cost
 - Simple small piping connections to process
 - No large vapor ducts or solids conveyors
 - Pre-piped & instrumented modular units

PDP Advantages – In Operation

- Lowest attainable chloride levels in dust and BL
- Lowest chemical losses (<4%)
 - Lowest make-up chemical cost
 - Less chloride input in make-up chemicals
 - Less sulfate to sewer (CaSO₄ dredging)
- Simple automated operation
- Little operator attention
- Operates independently of all other equipment

PDP Advantages – Maintenance

- Equipment proven in diverse installations
- Low maintenance requirement
- Easily stopped and isolated
- Maintenance can be performed outside of annual mill shut-down

Summary

- Chloride enters recovery through a variety of sources
- High chloride levels increases boiler fouling
- If Cl levels controlled, K has little impact on sticky temp.
- PDP system utilizes established short bed resin column technology to separate Cl from ESP ash
- The PDP system has high Cl removal, >90%
- Low chemical losses, <4%
- Low operating costs
- Small, modular units for low installation cost
- The PDP system has been proven with a mill trial and now full scale commercial installation

Thanks !

- Many thanks to the organizing committee for the opportunity to present this work.
- Many thanks to my colleagues in Paprican, Eco-Tec and NORAM
- Handouts / materials are available at the back

Other uses of short column ion exchange

- Remove chloride from recovery boiler ESP catch
- Boiler Feed Water Treatment
- Recover sulfuric acid from ClO₂ generator waste streams
- Separate sulfide from carbonate in green liquor