NORAM

engineering + constructors

Precipitator Dust Purification (PDP)

Chloride and Potassium Removal System

NORAM Engineering and Contractors, Ltd.

PAPTAC Fall 2015

Background

Make up Chemicals and NPE's

- **Make up Chemicals:** Na, S and Ca
- **NPE:** Si, Al, Fe, **K, Cl,** Mg, Mn, P, NI, Cr.
- **Organics:** C, H and O

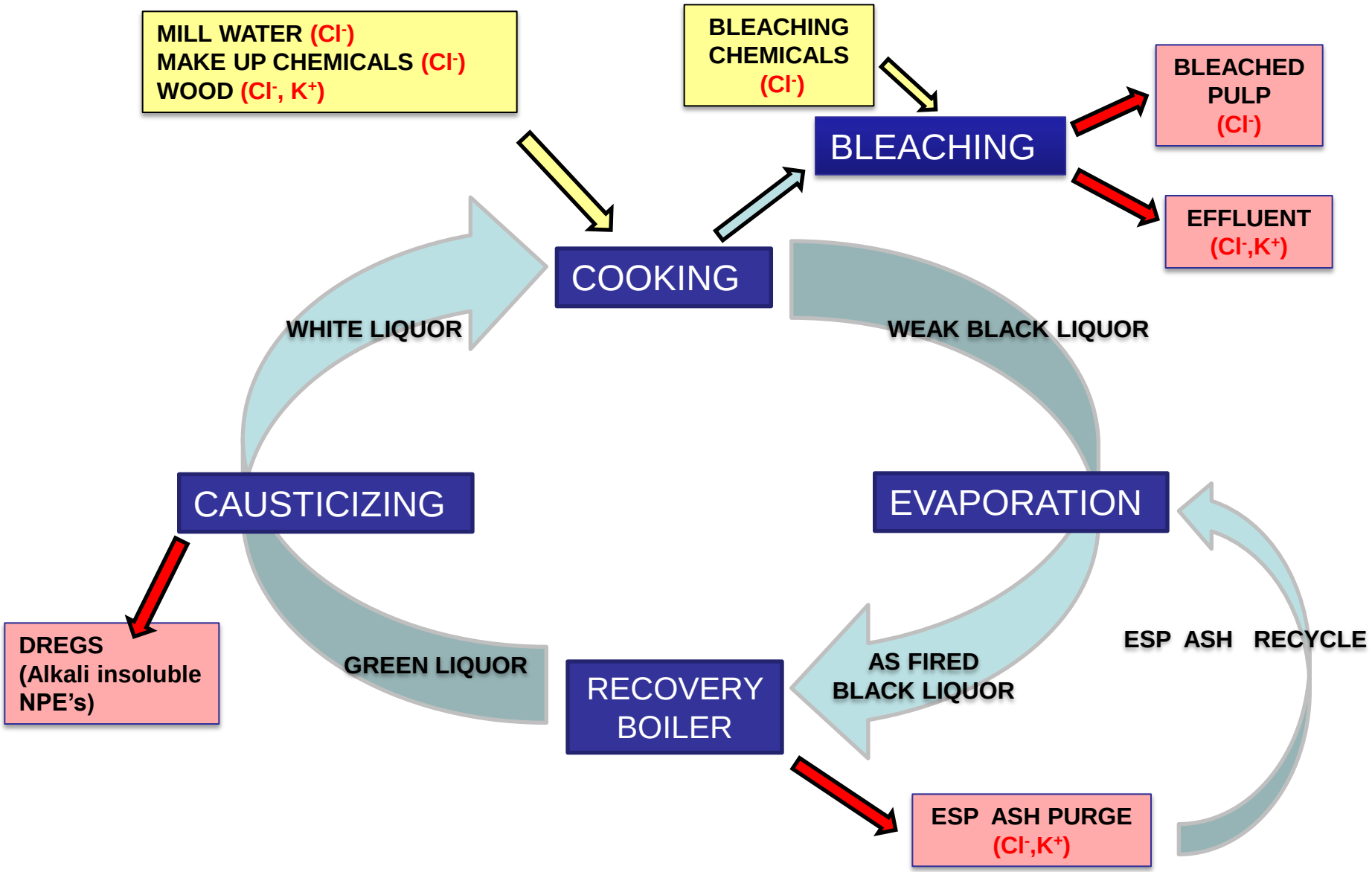
NPE's CLASSIFICATION

- **Highly soluble** in alkali and can build up without limit (**K and Cl**)
- **Partially Soluble** in alkali and are naturally purged by precipitation (Si, Al, P)
- **Highly insoluble** in alkali and are removed with GL dregs (Other NPE's)

As Fired BL Elemental Composition (72% Solids)	Wt % in DS
C	30 - 40
H	3.2 - 4
O	34 - 38
Na	17 - 22
S	3.6 - 5.6
K	*1 - 3*
Cl	*0.1 - 4*

Chloride and Potassium Sources, Routes and Outputs

Kraft Process General Diagram



Background

Chloride and Potassium Sources

Chloride

- Wood Furnish
  - Example: 2000 t/d @ 200 ppm = 0.4 t/d Cl
- Chemical make-up (NaOH, NaSH, sesqui, salt cake, etc.)
  - Example: 40 t/d Na_2SO_4 @ 0.5% = 0.2 t/d Cl
- Mill water
  - Example: 500 gpm at 100 ppm = 0.3 t/d Cl

Potassium

- Wood Furnish
  - Example: 2000 t/d @ 700 ppm = 1.4 t/d K

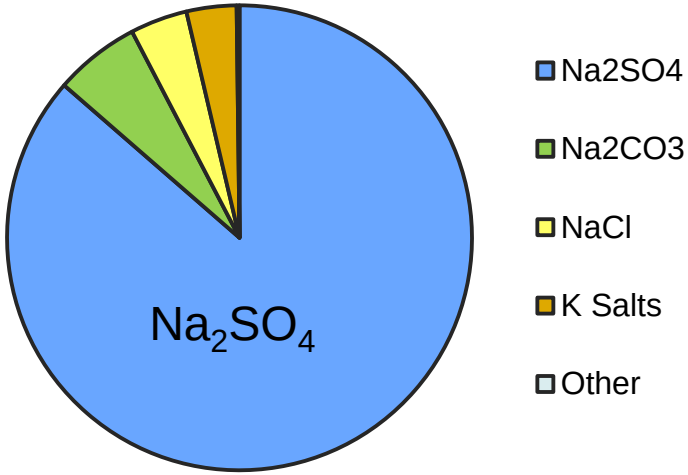
Effect of Chloride and Potassium

ESP Ash Composition

High chloride and potassium concentrations in the recovery boiler cycle can cause:

- Plugging: Reduced sticky temperature increases presence of molten phase which causes material in the flue gas to stick on metal surface
- Corrosion: Sticky deposits increase the rate of diffusion of both metal ions and corrosive gases setting up a galvanic cell
- Production loss: Frequent water washes
- Lower steam production
- Increase in soot blowing

Typical ESP Ash Composition Wt %



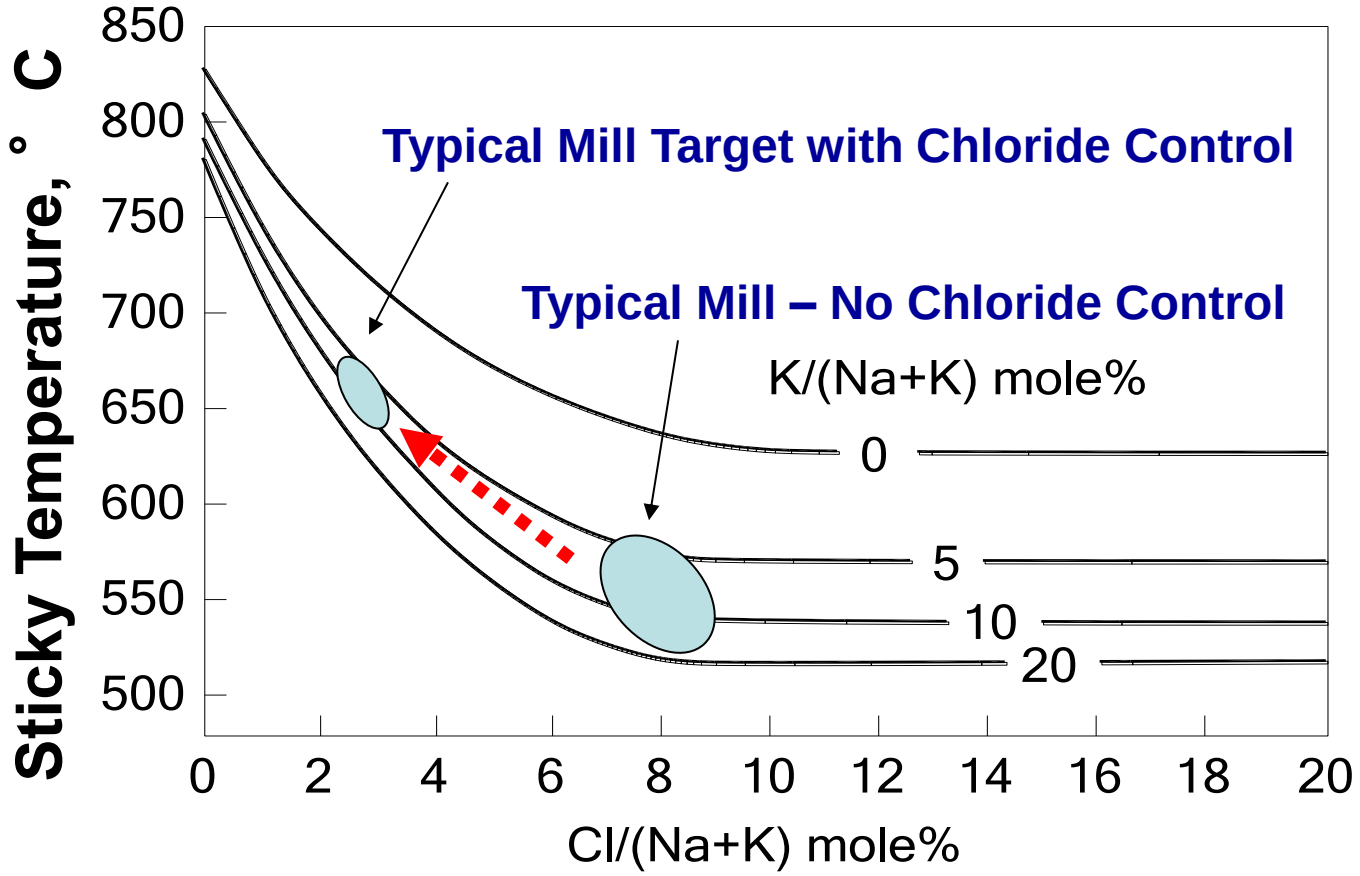
ESP Ash Composition:

- Chloride and potassium are enriched in ash due to higher vapor pressure compared to other sodium and sulphur compounds

- If ESP catch is purged to remove chloride and potassium – costly makeup of sodium and sulfur chemicals is needed.

Sticky Temperature

Effect of Chloride and Potassium

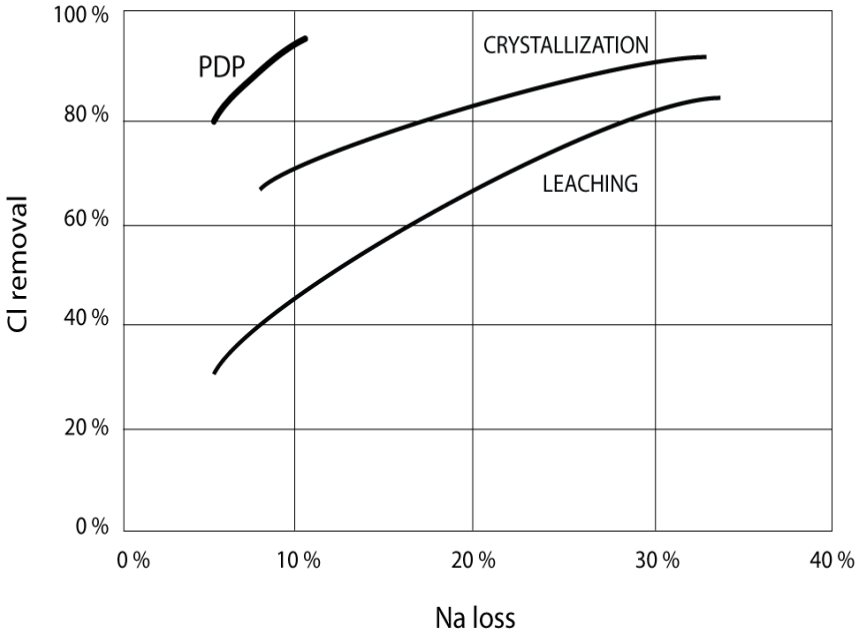


- *It is important to note that when the deposit Chloride levels are low, potassium has very little effect on sticky temperature*

Chloride and Potassium Removal Processes in Kraft Mills

Comparison of Available Technologies

Process	% Removal		% Recovery		Temp, C
	Cl-	K-	Na-	SO4	
Valmet Ash leach	69	69	80	85	90
HPD CRP	70-85	50-85	80-82	80	75
Andritz ARC	90	90	80	NR	60-80
Andritz Leaching	70-85	NR	60-80	NR	60
Eka PDR	90	90	NR	80	75
Mitsubishi, MPR	90	75	70	75	40/15
Ecp-Tec NORAM PDP	97	5	94	99	40-60

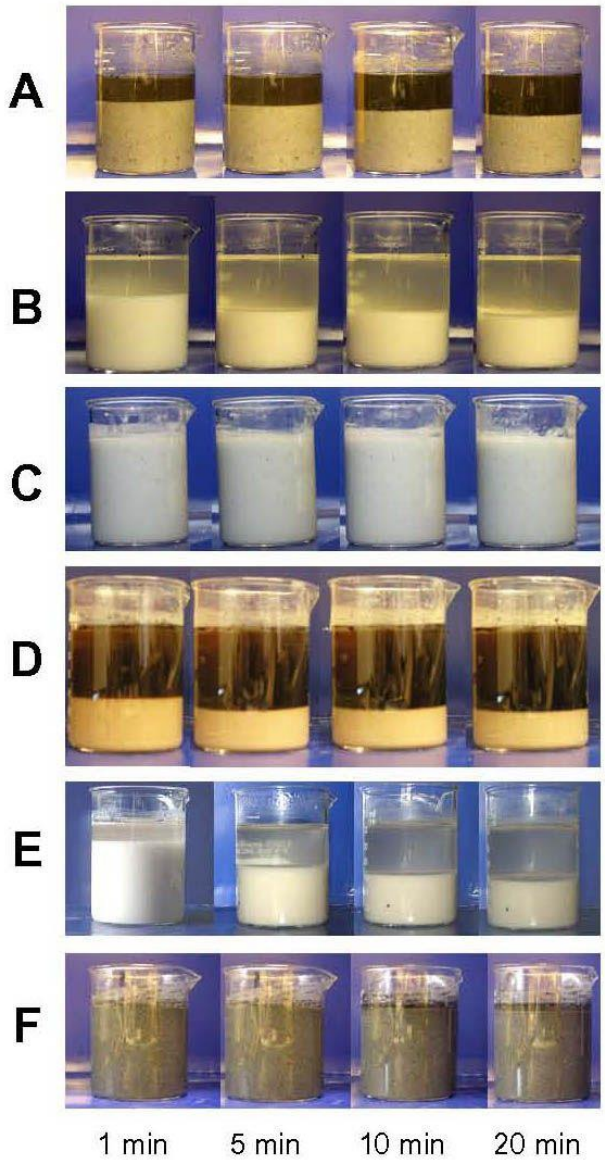


Can also be used to treat leach and crystallizer effluent to recover sulfate and carbonate while rejecting chloride and potassium

Different methods for the purge of Chlorides and Potassium from ESP dust in Kraft mill, Ulrica Johansson, Lund Institute of Technology, February 2005.

Effect of Carbonate

Reduced Effectiveness in Competitor Systems



1.2% CO_3

0.3% CO_3

12.4% CO_3
(Poor settling)

2.7% CO_3

0.1% CO_3

6.4% CO_3
(Poor settling)

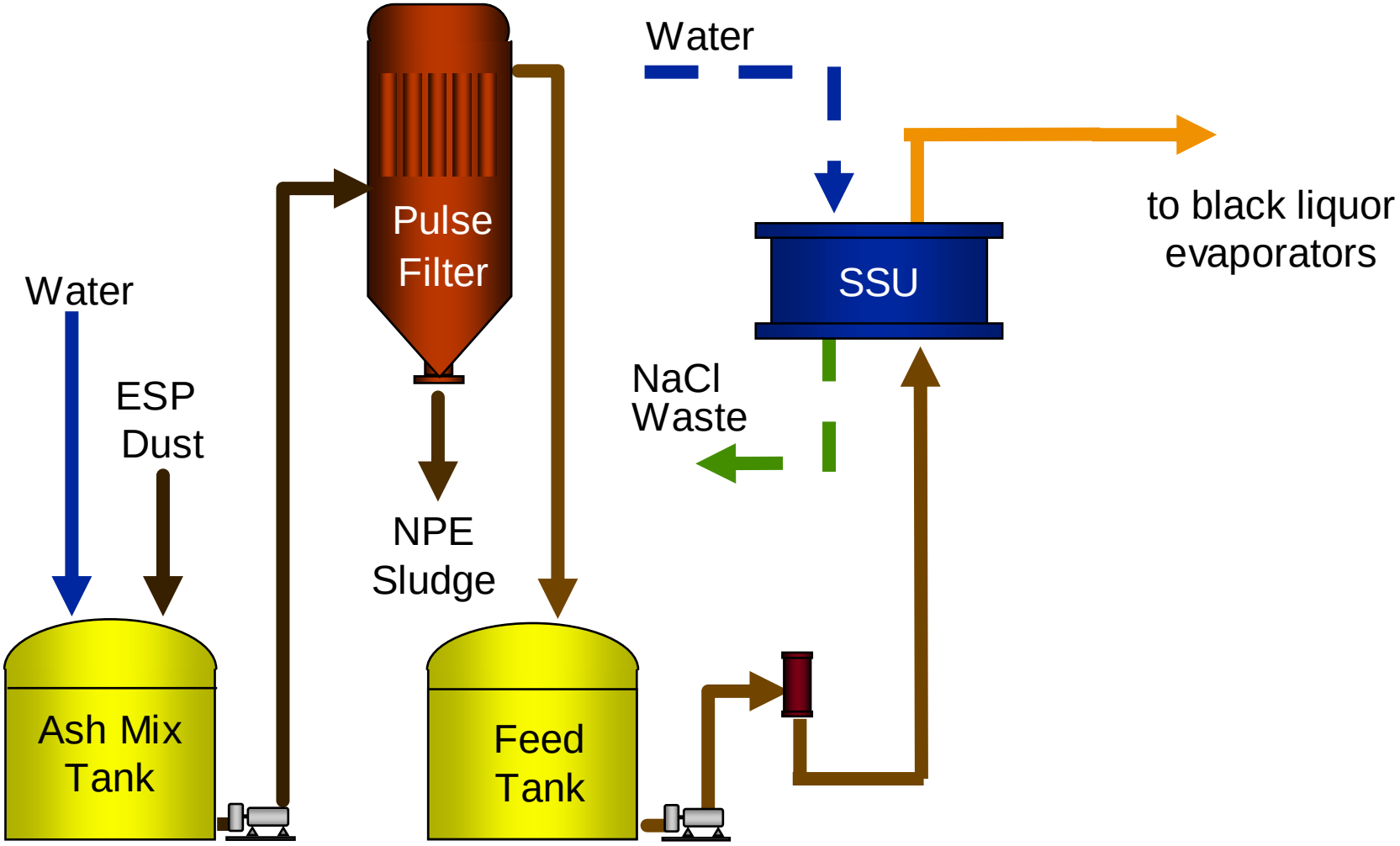
Competing chloride removal systems based on crystallization or leaching have poor performance on ESP dust with > 5% CO_3

At <5% CO_3 all carbonate is typically lost in effluent and must be made up with NaOH

PDP handles any CO_3 content with the same recovery as SO_4

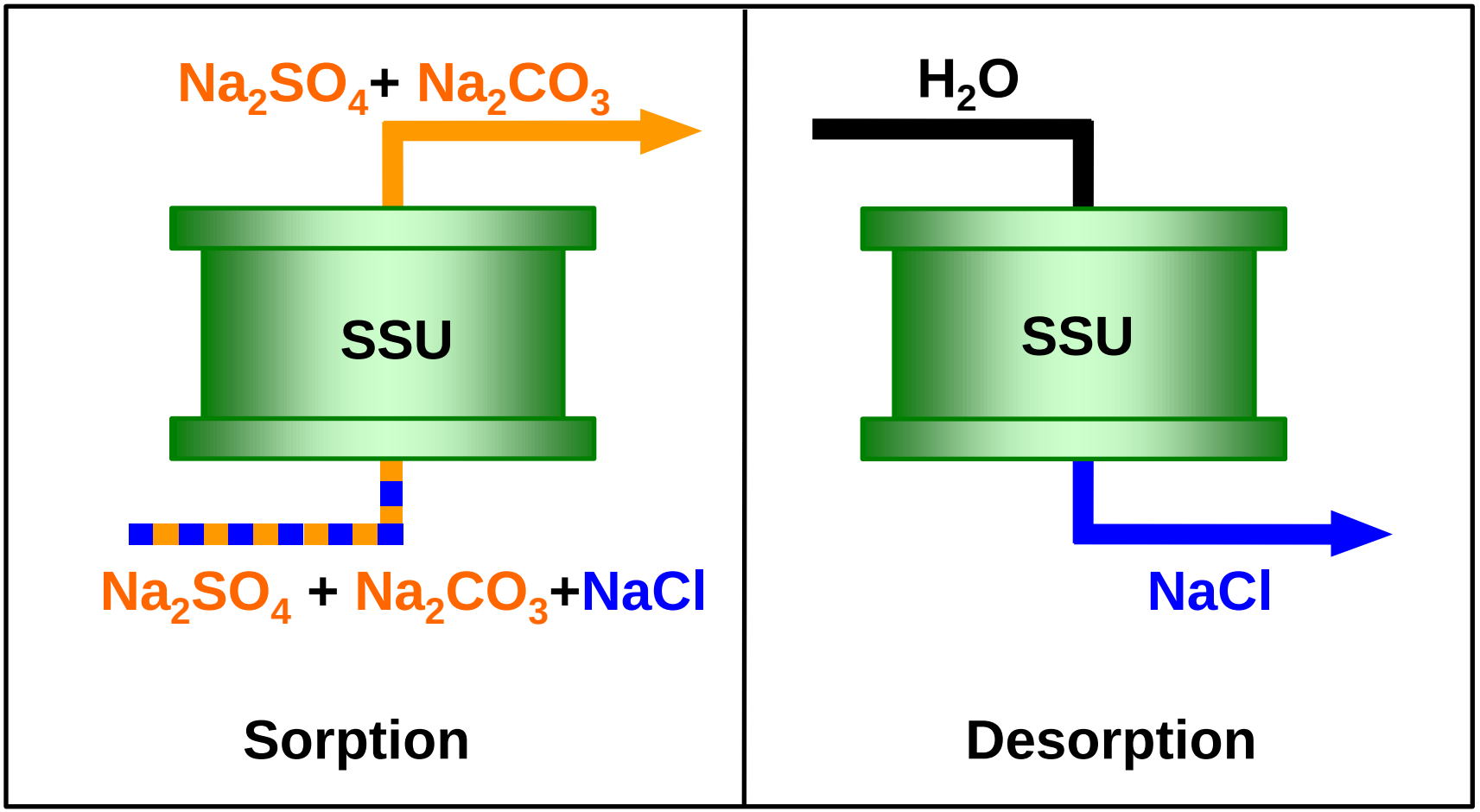
Process Schematic

Chloride Removal Only



Short Column IX Resin Beds

Chloride Removal



Short Column IX Resin Beds

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

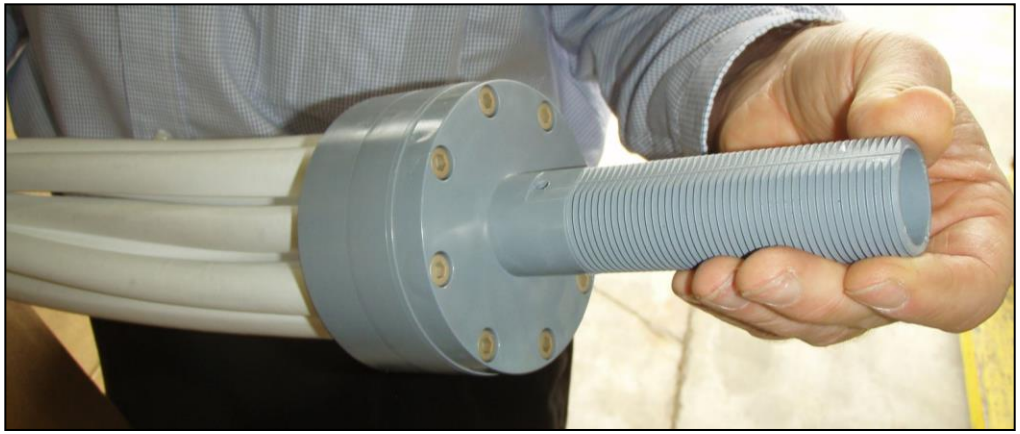
PDP Installation

Arauco 30 TPD System (Pulse Filter and Break Tank)

Pulse Filter Socks

High Surface Area Filter Elements

- Replaces sock over core-tube design
- Easy replacement
- High area/unit filter
- Solids removed via periodic reverse flow
- Break Tank controls reverse flow pressure

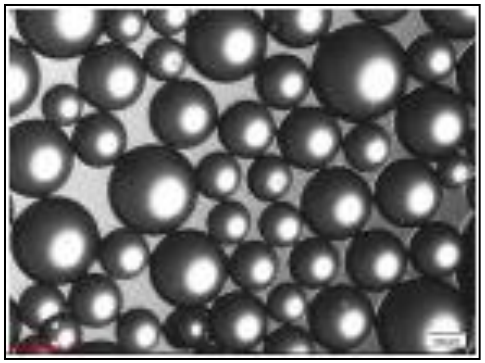


PDP Installation

Arauco 30 TPD System (SSU Resin Bed and Feed Tanks)

Resin Beads

Ion Exchange Bed and Feed Tanks for Cl/K Removal



PDP Installation

Rocktenn 75 TPD System (Alabama, USA)

PDP Reference List

Eight Installations

Company	Location	Start-up Date	Size
Mill A	Southeast USA	2008	50 t/d
Rocktenn	**Alabama, USA**	**2010**	**75 t/d**
Mill B	Southeast USA	2011	25 t/d
Mill C	Brazil	2013	58 t/d
Mill D	Brazil	2014	60 t/d
Arauco	**Chile**	**2014**	**30 t/d**
Mill E	Southeast USA	2014	25 t/d
Mill F	Northwest USA	Expected 2015	40 t/d

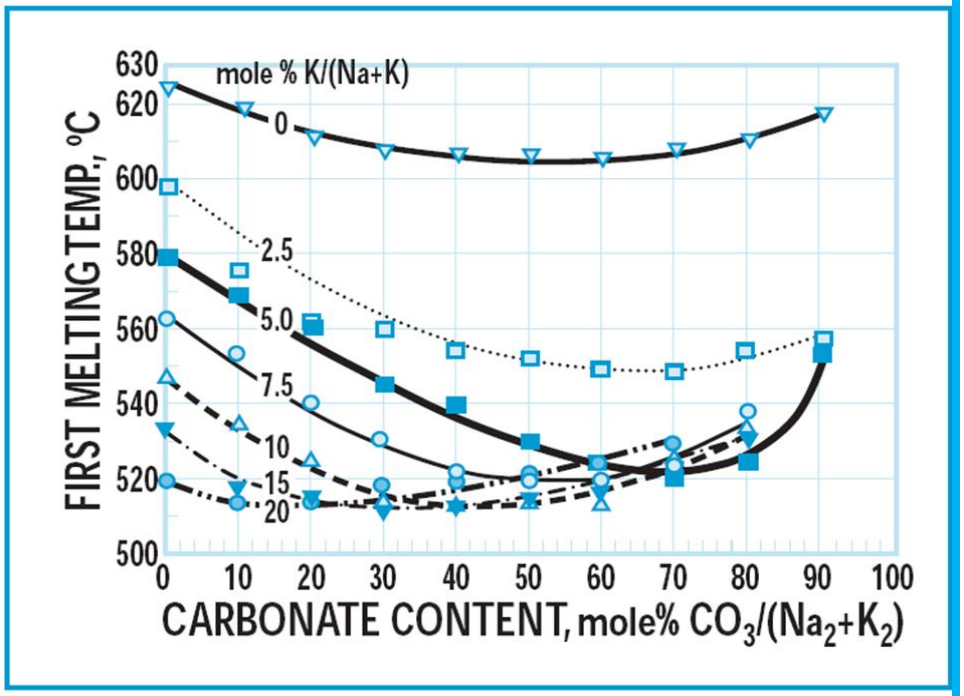
Why K Removal for Mill's with Low Cl Content

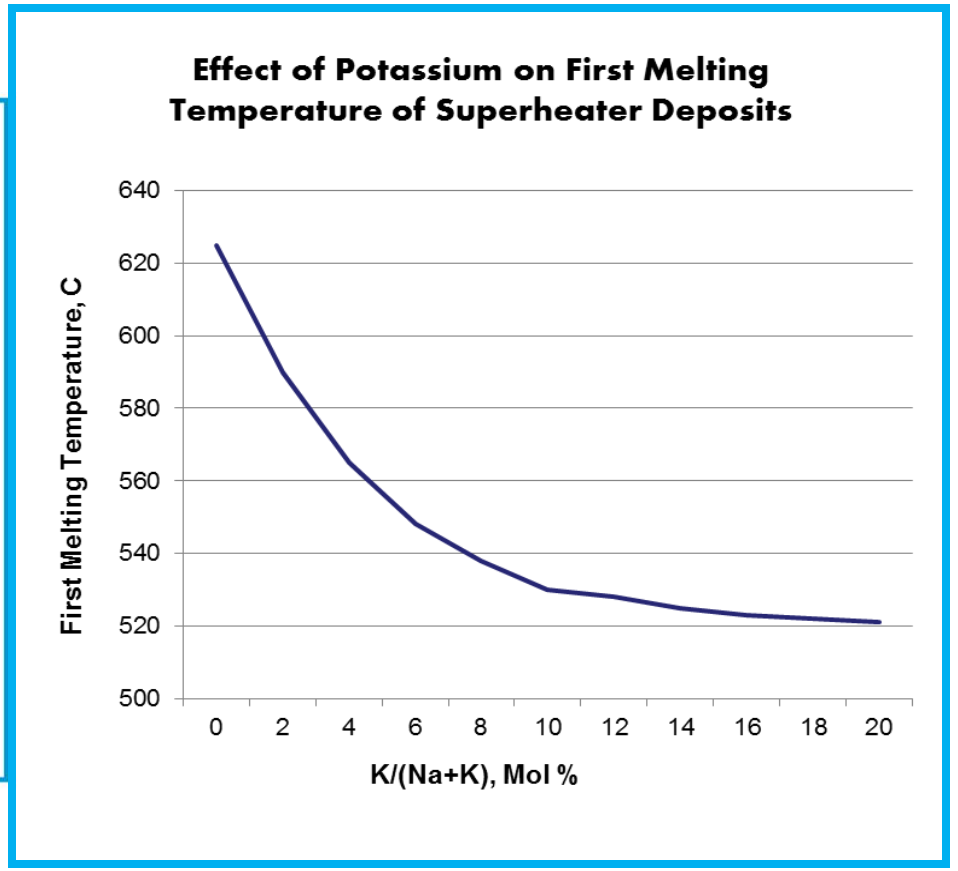
Effect of Potassium and Carbonate on FMT

- Mills with high temperature boilers (steam temperature >450 C) can undergo rapid superheater corrosion if the tube temperature exceeds first melting temperature of the deposit
- Potassium has the greatest effect on FMT followed by carbonate and sulfide
- Although chloride has no additional effect on the deposit FMT, high chloride levels can make the deposit more corrosive by increasing the molten phase and thereby increasing the fluxing effect
- High pressure boilers typically target K levels of <4 wt% in ash to minimize superheater corrosion

Why K Removal for Mill's with Low Cl Content

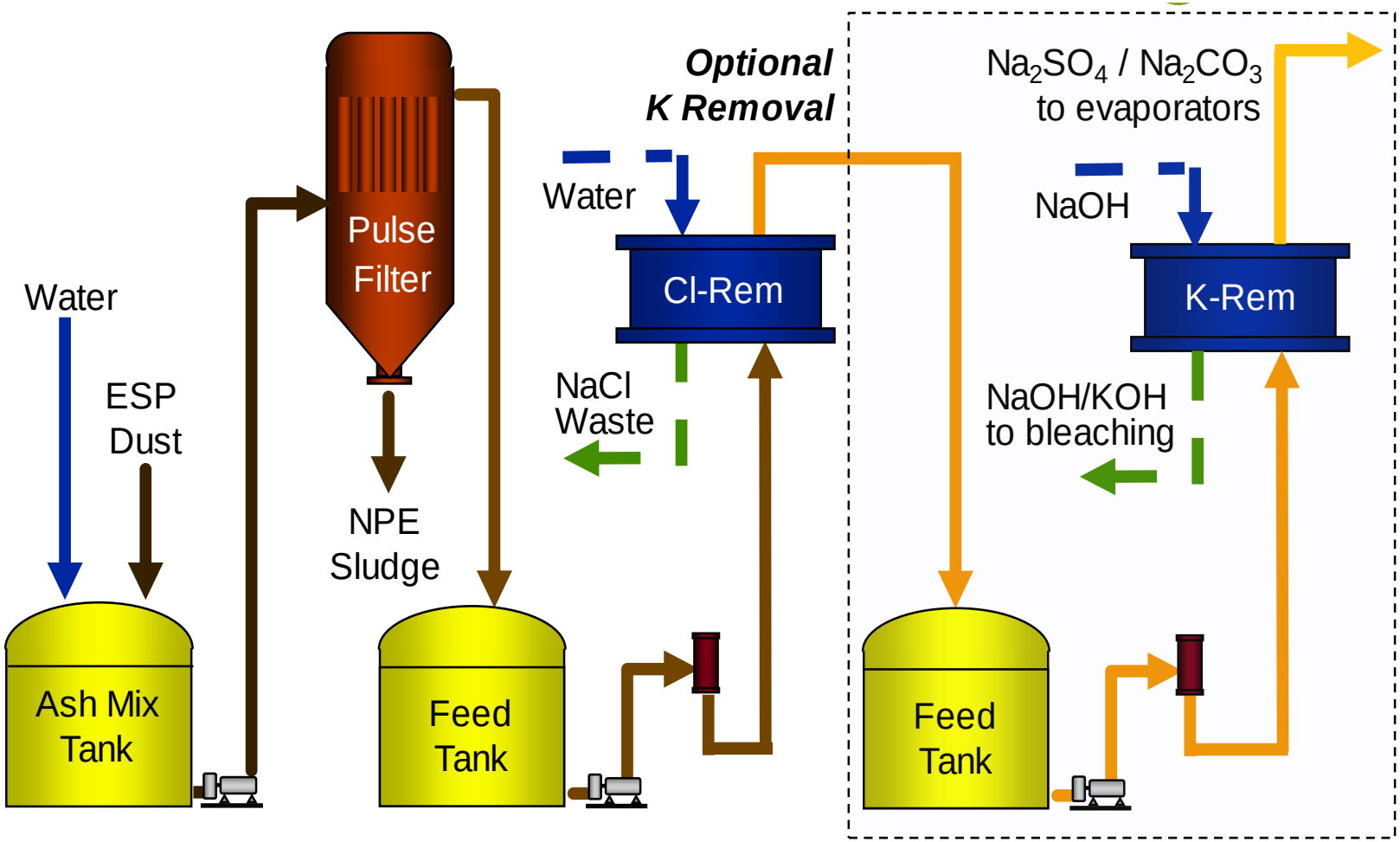
Effect of Potassium and Carbonate on FMT





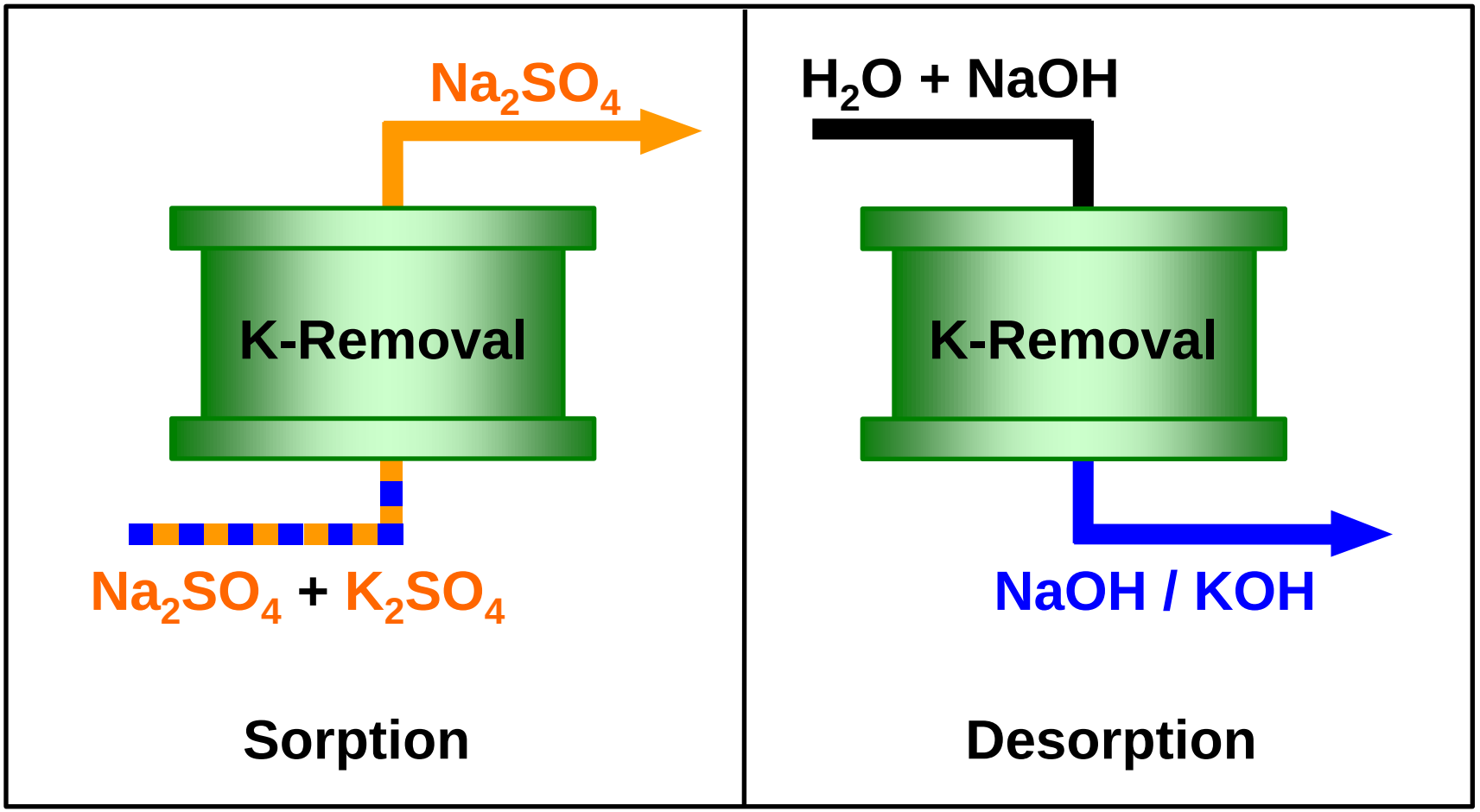
Process Schematic

Optional Potassium Removal



Short Column IX Resin Beds

Potassium Removal



PDP-K System Efficiency

High Chloride/ Potassium Removal and Chemical Recovery

Chloride Removal	80-97%
Potassium Removal	80%*
Carbonate Recovery	90-96%
Sulfate Recovery	90-96%
Pulping Sodium Recovery	90-96%

- These performances can be tuned to either maximize SO4 and CO3 recovery or maximize Cl and K removal
- Recent PDP start-ups have achieved >95% Cl removal with >95% chemical recovery

** If potassium removal ion exchange bed is part of installation removal efficiency depends on available caustic for regeneration*

PDP Advantages

Construction

- Small footprint,
  - Flexible layout
  - 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

- Highest chloride removal
- Optional potassium removal
- Lowest chemical losses (<10% SO_4 and CO_3)
  - Lowest make-up chemical cost
  - Less chloride input in make-up chemicals
  - Less sulfate to sewer ($CaSO_4$ dredging)
- Simple automated operation
- Little operator attention
- Operates independently of all other equipment
- But! Requires attention to filter maintenance

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

PDP System Requirements

For a 75 TPD System (Typical)

With Chloride Removal Only

Soft Water (Dissolving Ash and Regenerating Resin)	65 gpm
Additional Evaporator Steam	40 TPD
Power Consumption	50 kW

With Chloride and Potassium Removal

Soft Water (Dissolving Ash and Regenerating Resin)	95 gpm
Additional Evaporator Steam	45 TPD
Power Consumption	85 kW

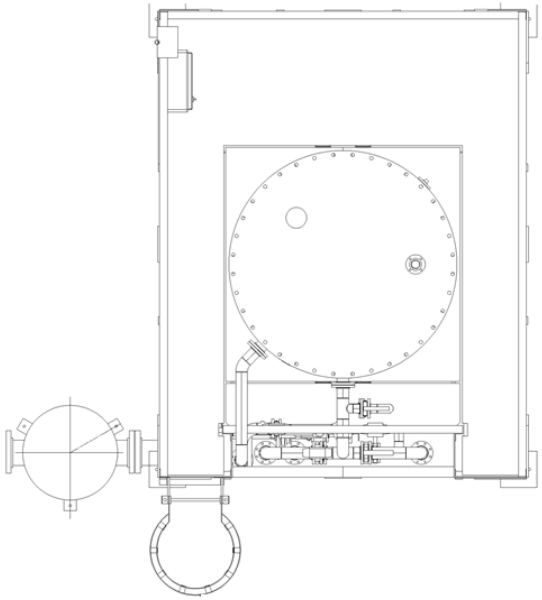
PDP System Footprint

Small and Flexible Layout

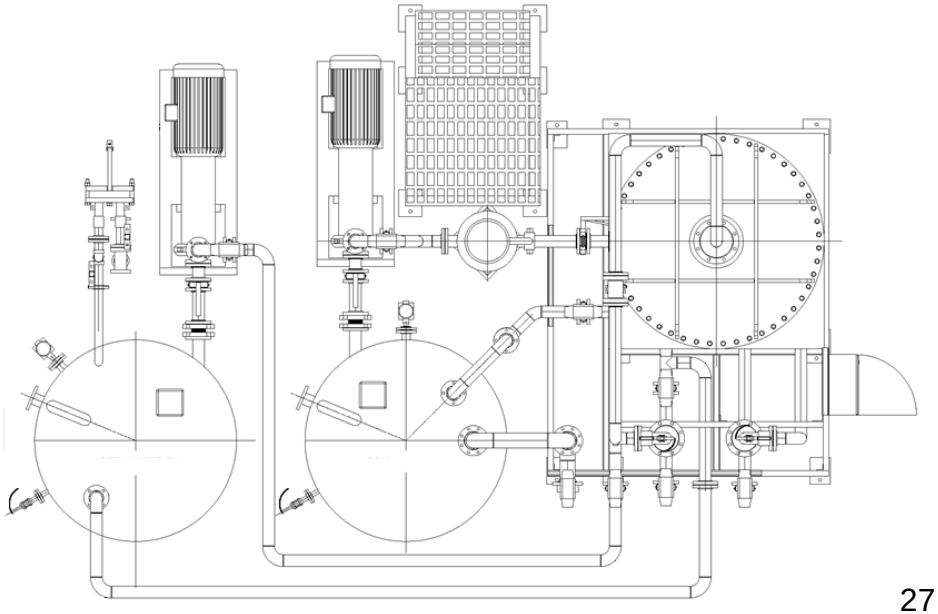
75 TPD Dimensions

	Length	Width	Height
Pulse Filter	20 ft	20 ft	30 ft
Ion Exchange (Cl or K removal)	20 ft	15 ft	10 ft

Pulse Filter



Ion Exchange System



Thank You

Questions?