TAPPI KRAFT RECOVERY SHORT COURSE

RECAUSTICIZING

CHAPTER 2.1 - PRINCIPLES AND PRACTICE

BY

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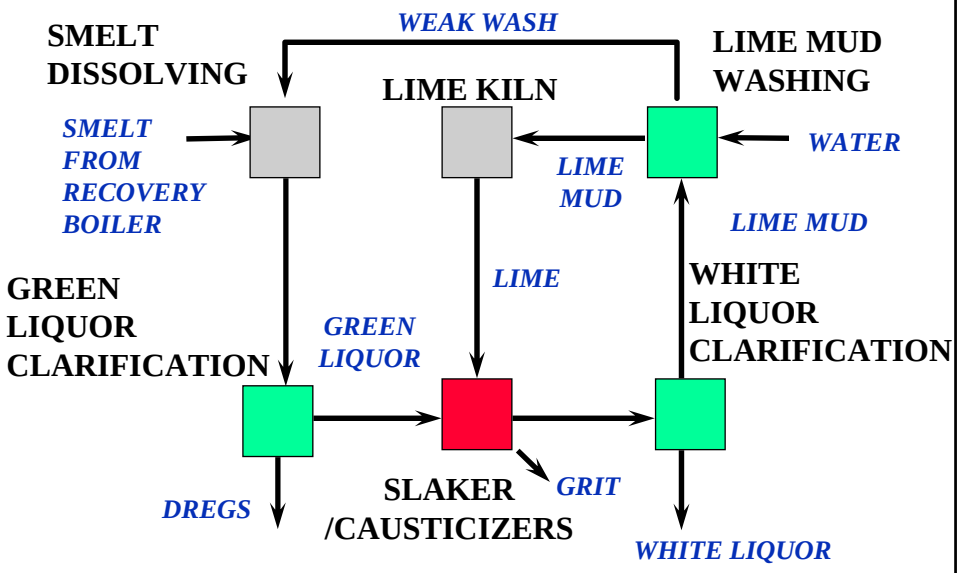
VECTOR PROCESS EQUIPMENT INC.

TOPICS

- **BASIC CHEMISTRY**
- **FLOWSHEET OPTIONS**
- **GREEN LIQUOR PREPARATION**
- **WHITE LIQUOR PREPARATION**
- **LIME MUD WASHING**
- **CONTROLS**

RECAUSTICIZING CYCLE



BASIC CHEMISTRY

GREEN LIQUOR + LIME = WHITE LIQUOR + LIME MUD

$$Na_2CO_3 + H_2O + CaO = 2NaOH + CaCO_3$$

CHEMICAL REACTIONS

- SLAKING

$$CaO + H_2O \rightarrow Ca(OH)_2 + Heat$$

- CAUSTICIZING

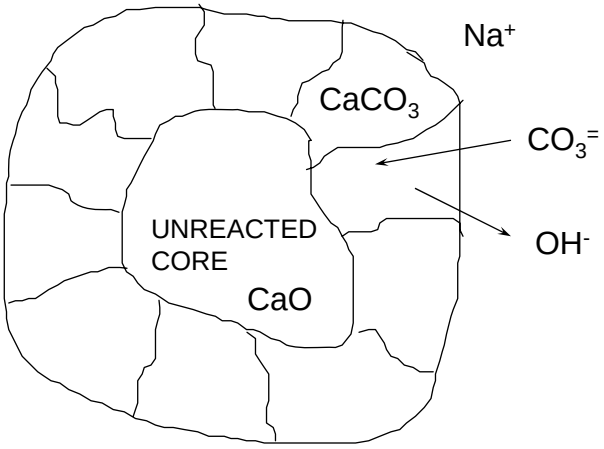
$$Ca(OH)_2 + Na_2CO_3 \rightleftharpoons 2NaOH + CaCO_3$$

OVERALL REACTION

$$Na_2CO_3 + H_2O + CaO \rightleftharpoons 2NaOH + CaCO_3$$

- EQUILIBRIUM REACTION
- REVERSIBLE
- INCOMPLETE

REACTION AT SOLID/ LIQUID INTERFACE



DEFINITIONS

TTA = TOTAL TITRATABLE ALKALI

$NaOH + Na_2S + Na_2CO_3$

AA = ACTIVE ALKALI

$NaOH + Na_2S$

EA = EFFECTIVE ALKALI

$NaOH + ½\ Na_2S$

SULFIDITY %

Na_2S / AA or Na_2S / TTA

DEFINITIONS

CE = CAUSTICITY %

$$\frac{NaOH \times 100}{NaOH + Na_2CO_3}$$

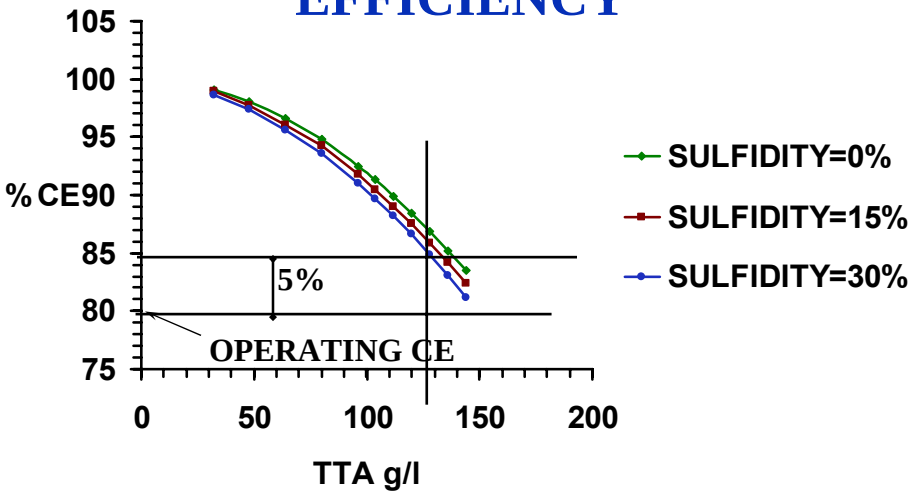
Lime Availability %

CaO / Kiln Product

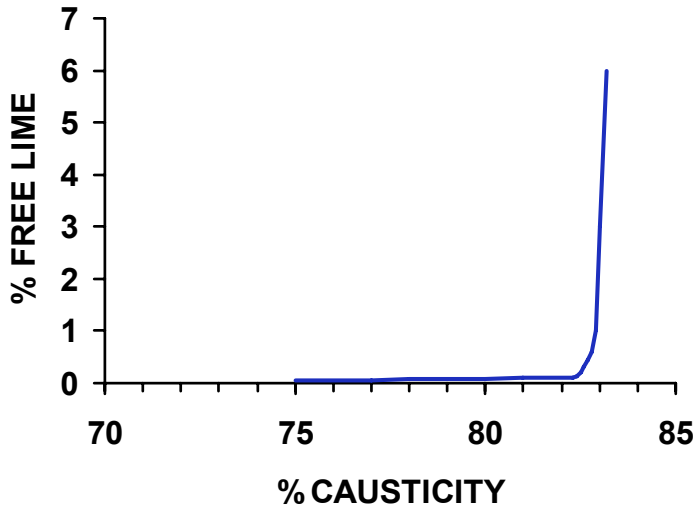
Note: All chemical concentrations are expressed on a Na_2O basis e.g. TTA = 120 g/l as Na_2O

Other units of measure are lb/ft^3 & lb/gal

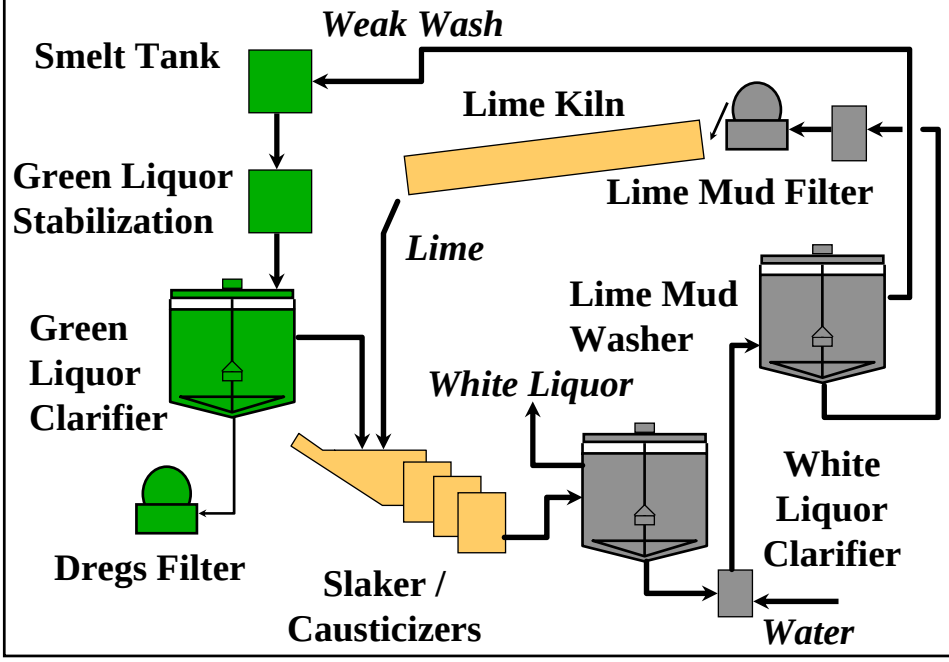
OPERATING CAUSTICIZING EFFICIENCY



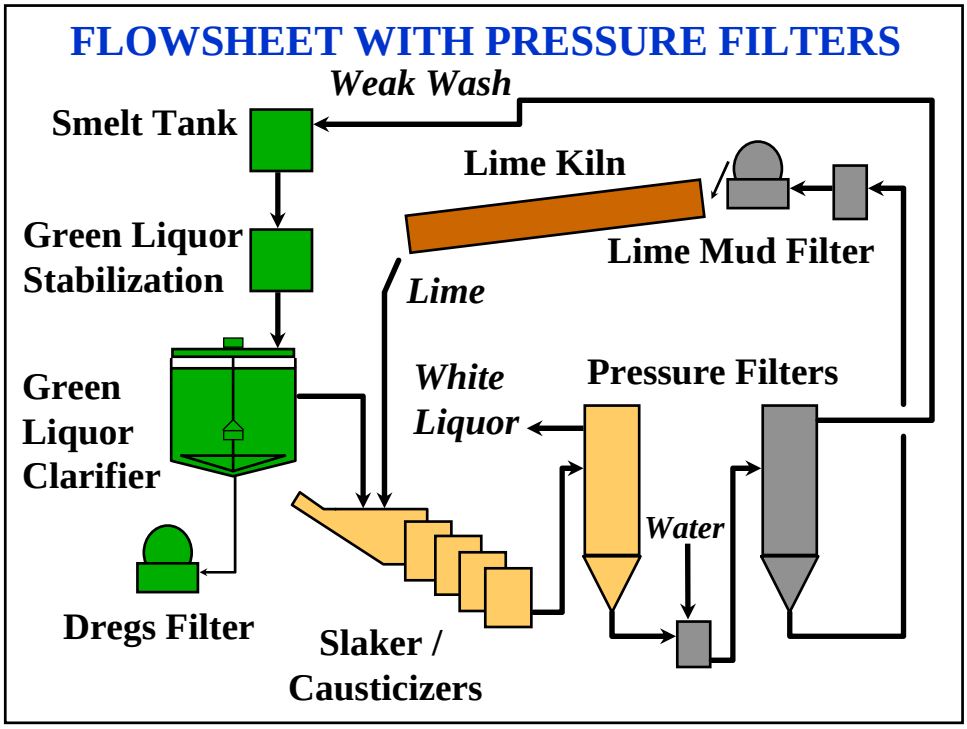
FREE CaO vs CAUSTICITY



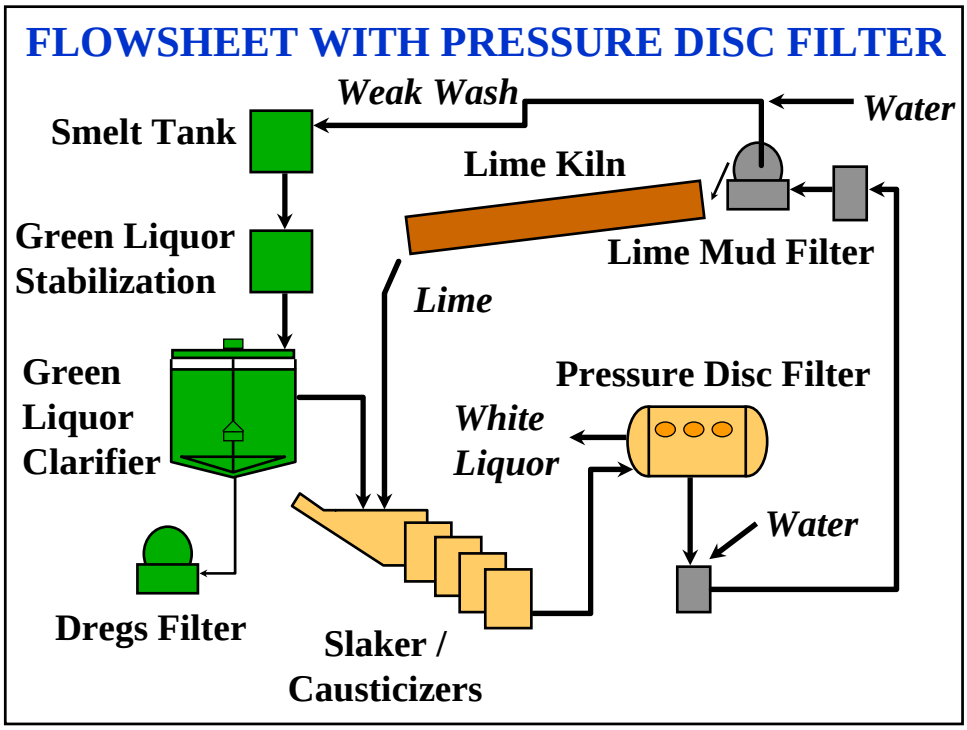
FLOWSHEET WITH CLARIFIERS



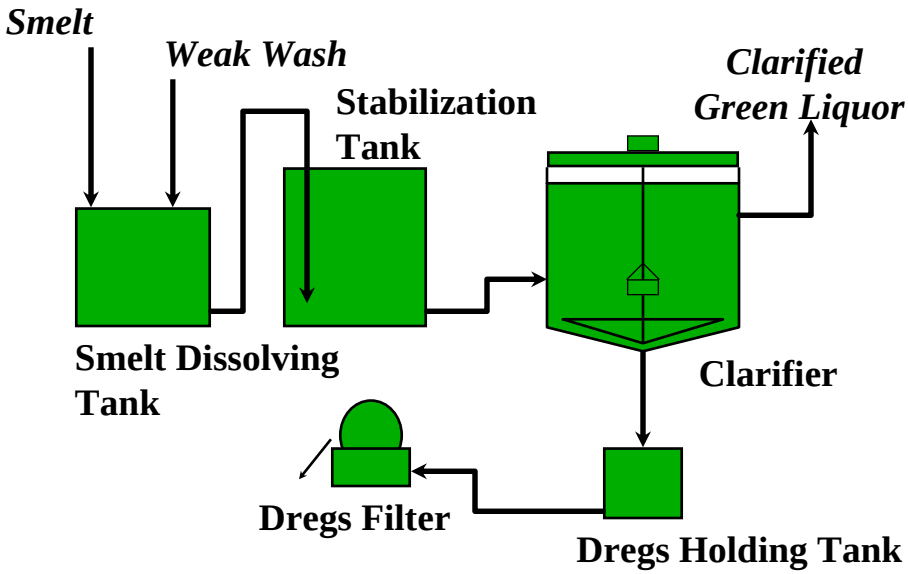
FLOWSHEET WITH PRESSURE FILTERS



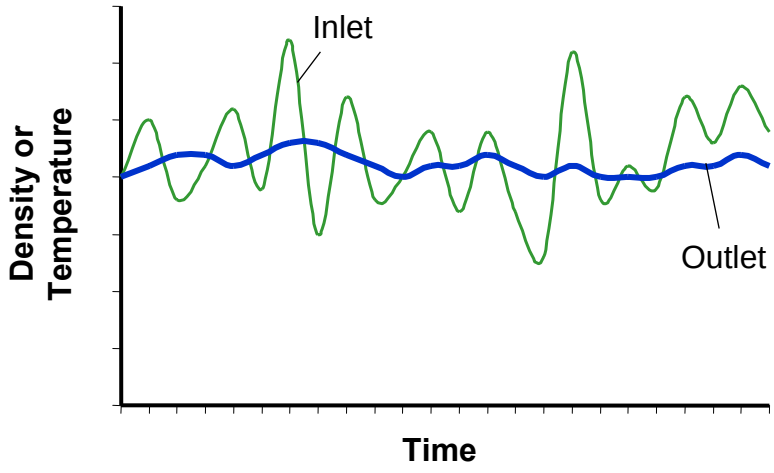
FLOWSHEET WITH PRESSURE DISC FILTER



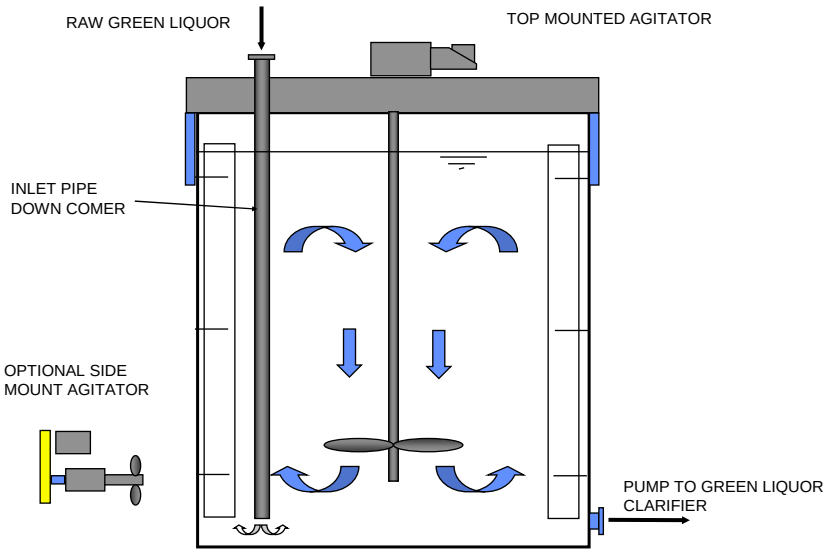
GREEN LIQUOR PREPARATION



Variation in Green Liquor Density or Temperature in Stabilization Tank



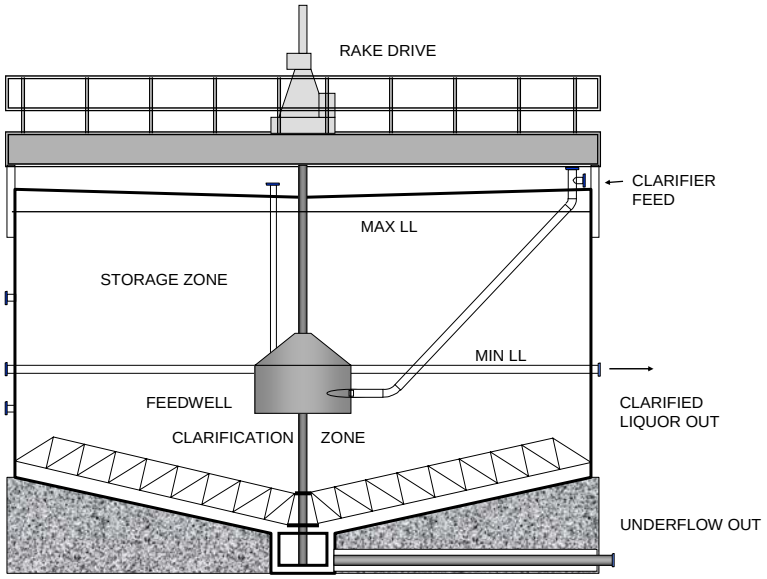
RAW GREEN LIQUOR STABILIZATION TANK



GREEN LIQUOR CLARIFICATION OPTIONS

- **SEDIMENTATION CLARIFIERS**
- **PRESSURE FILTERS**
  - **CROSS FLOW FILTERS**
  - **SOCK TYPE FILTERS**

GREEN LIQUOR CLARIFIER



CLARIFIER INTERNALS

Photo courtesy of Dorr-Oliver Eimco

Clean Green Liquor!

GREEN LIQUOR CLARIFIER PROBLEMS

DIRTY GREEN LIQUOR

- **Clarifier too small (rise rate too high)**
- **Properly designed internal components**
- **Use of Contaminated condensate**
- **Lack of Stabilization tank**
- **Settling aid addition problem (Polymer)**

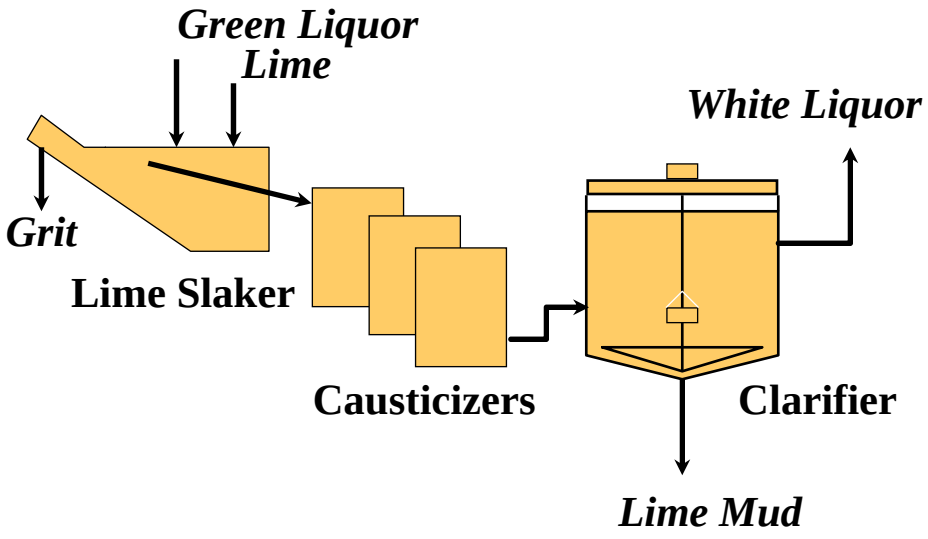
DREGS PRECOAT FILTER

Photo courtesy of Dorr-Oliver Eimco

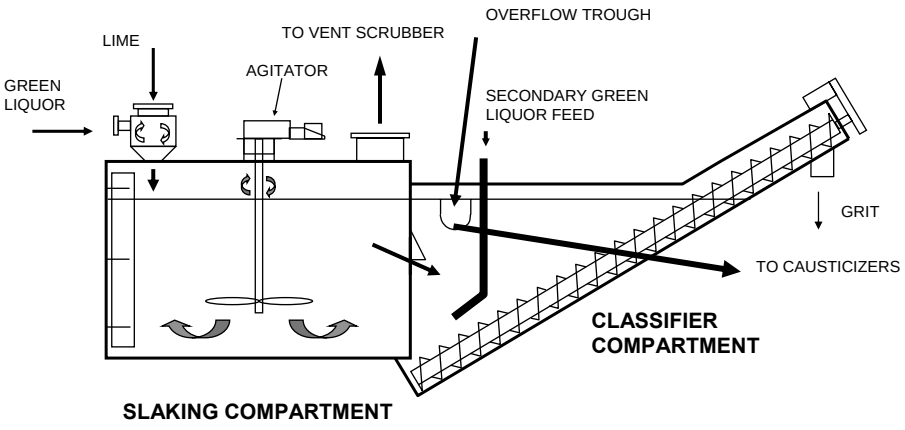
DREGS FILTER OPERATIONAL PROBLEMS

- **Wet cake discharge**
- **High soda loss**
- **Difficulty forming a precoat**

WHITE LIQUOR PREPARATION



LIME SLAKER



LIME SLAKER

Photo courtesy of Kadant Black Clawson Inc. – Goslin™ Products Group

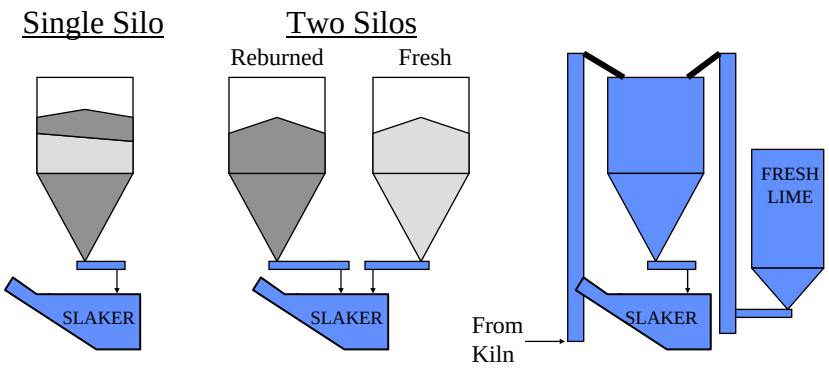
LIME SLAKER

- **Sized based on retention time in slaking compartment.**
  - **For Clarifiers – 15 to 20 mins**
  - **For Pressure filters – 20 to 25 mins**
- **Correct operation determines white liquor strength**

LIME SLAKER PROBLEMS

- **OVERLIMING**
  - **Lime feed rate and or GL flow and strength**
- **BOILING**
  - **GL Temperature control and or lime feed rate**
- **GREEN LIQUOR TEMPERATURE**
  - **Heating – Direct and indirect type heaters**
  - **Cooling – Indirect heat exchangers**
- **FRESH LIME MAKE-UP - the way it is added**
- **GRIT – too much or too little grit can be an indicator of a problem**

FRESH LIME MAKE-UP



SLAKER GRIT HANDLING

- **WASH GRIT TO pH LESS THAN 12.5 WITH GRIT WASHER**

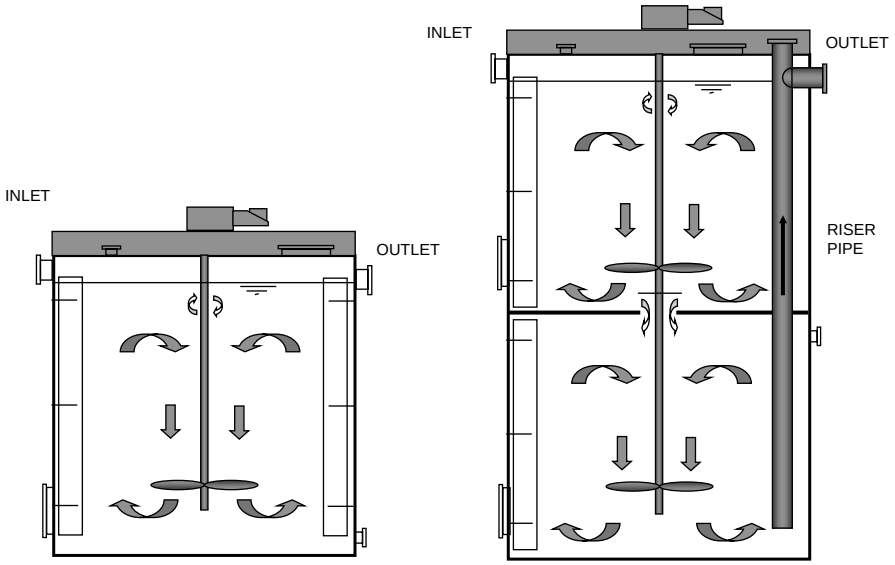
Photo courtesy of Kadant Black Clawson – Goslin™ Products Group

SLAKER GRIT HANDLING

- **GRIND OR PULVERIZE GRIT AND FILTER ON DREGS FILTER OR RECYCLE TO LIME SLAKER**

Photo courtesy of Kadant Black Clawson – Goslin™ Products Group

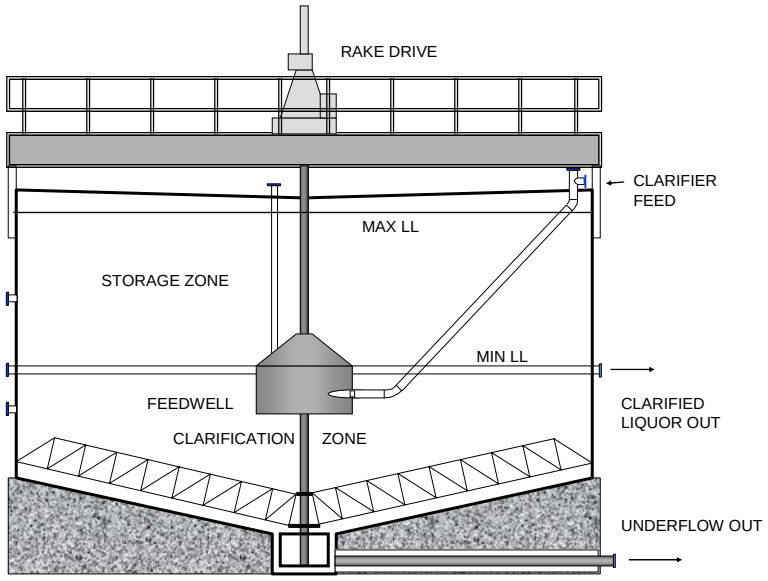
CAUSTICIZERS



WHITE LIQUOR CLARIFICATION

- SEDIMENTATION CLARIFIERS
- VERTICAL TUBE TYPE PRESSURE FILTERS
- PRESSURE DISC FILTERS

WHITE LIQUOR CLARIFIER



WHITE LIQUOR CLARIFIER

For successful clarifier operation

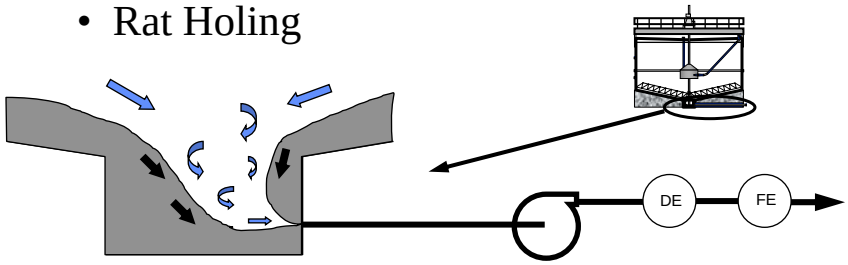
- Causticizer retention of 90 minutes
- Good accurate torque indication on rakes
- Properly sized variable speed underflow pumps with density and flow measurement

WHITE LIQUOR CLARIFIER PROBLEMS

- **CLOUDY OVERFLOW**
  - **Over Liming**
  - **Fresh Lime**
- **LOW UNDERFLOW SOLIDS**
  - **Over Liming**
  - **Fresh Lime**
  - **Rat Holing**
  - **Pumping Rate**

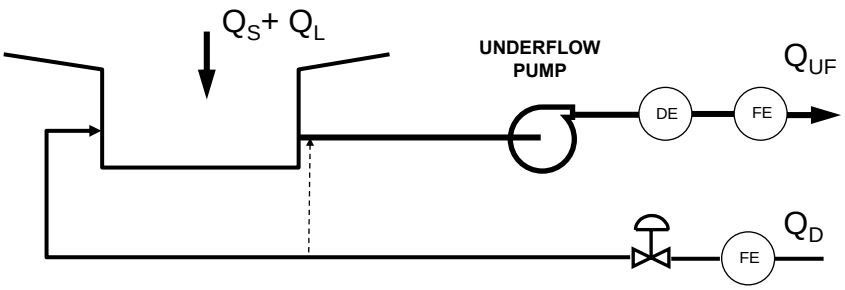
WHITE LIQUOR CLARIFIER PROBLEMS

- Rat Holing



WHITE LIQUOR CLARIFIER PROBLEMS

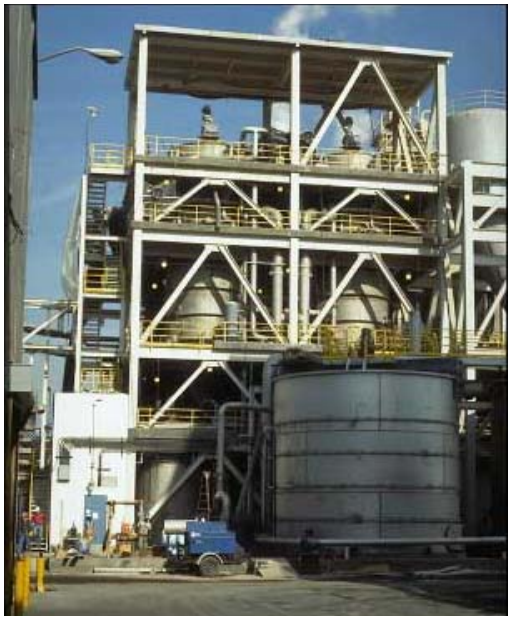
- Pumping Rate



$$Q_{UF}=Q_S+Q_L+Q_D$$

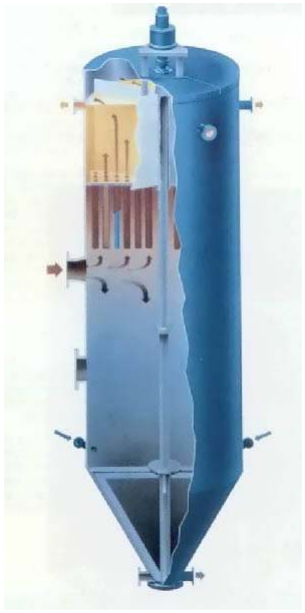
WHITE LIQUOR CLARIFIER PROBLEMS

- Pumping Rate
  - Mass flow of solids = Slaker solids output.
  - Slaker solids output calculated from Green Liquor flow and Lime rate.



VERTICAL PRESSURE FILTER

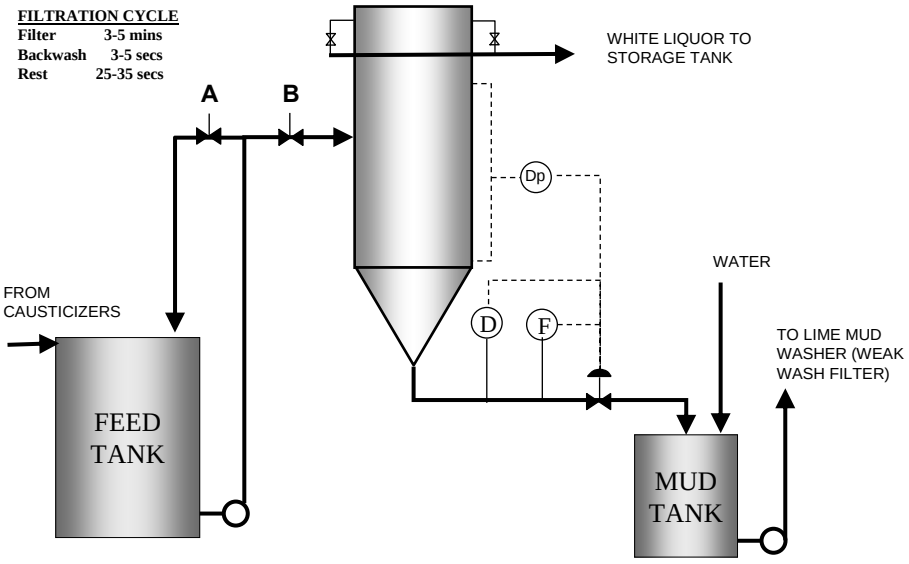
Photo courtesy of Kadant Black Clawson – Goslin™ Products Group



VERTICAL TUBE TYPE PRESSURE FILTER

Photo courtesy of Kadant Black Clawson – Goslin™ Products Group

PRESSURE TUBE TYPE FILTERS



PRESSURE TUBE TYPE FILTERS

Acid washing

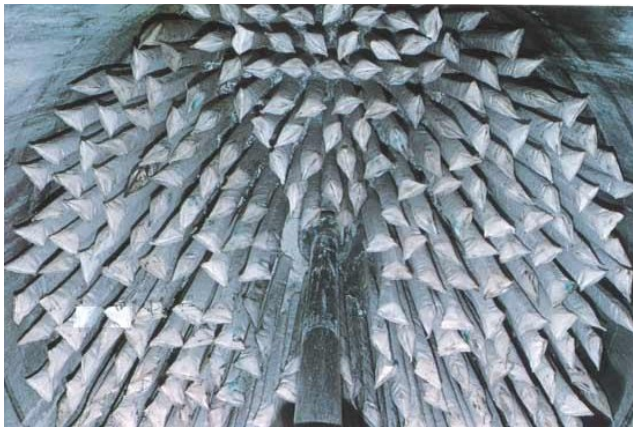
- Interval between washes 4 – 8 weeks
- Acid types
  - Sulphamic, Hydrochloric, Formic
- Alternative strategy
  - Change filter socks every 6 months or when needed.

PRESSURE TUBE TYPE FILTERS

For successful operation of pressure filters.

- Clean green liquor < 100 mg/l
- Causticizer retention time 150 -180 minutes.
- Causticizing control system.

PRESSURE FILTER INTERNALS



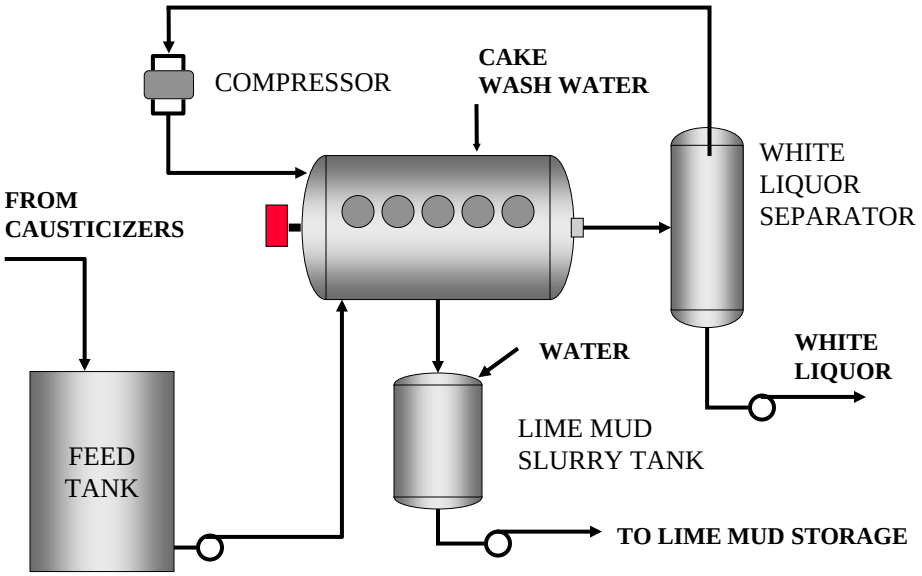
PRESSURE FILTER PROBLEMS

- **FREQUENT ACID WASHING**
  - **Green Liquor Dregs – contaminates filter socks**
  - **Overliming – temporary blinding of filter socks**
- **HIGH PRESSURE DROP**
  - **Overliming**
  - **Dregs**
  - **High Mud Level**
- **SHORT FILTER SOCK LIFE**
  - **Dregs contamination**

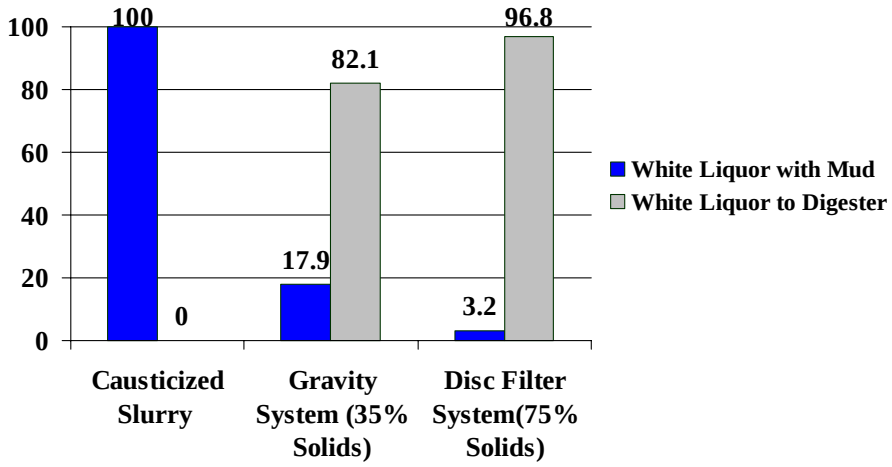
WL PRESSURE DISC FILTER

Photo courtesy of Dorr-Oliver Eimco

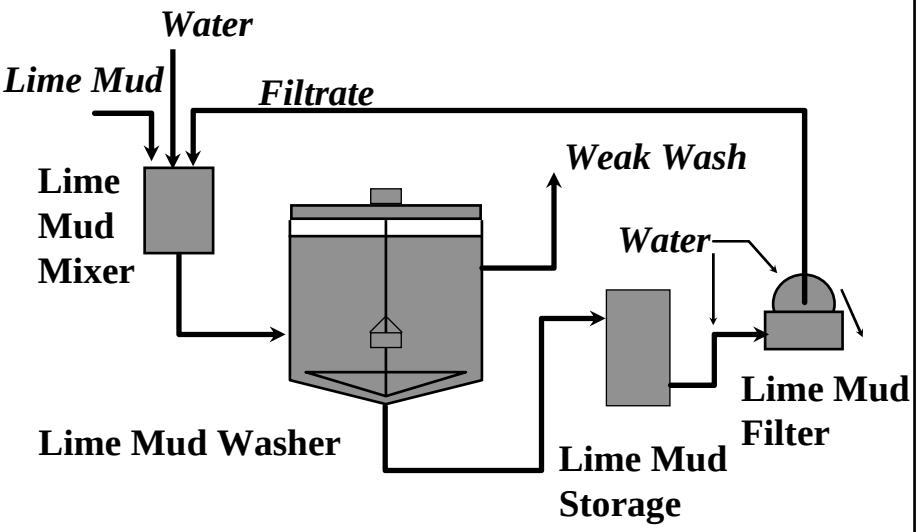
WHITE LIQUOR PRESSURE DISC FILTER



LIQUOR YIELD



LIME MUD WASHING



LIME MUD WASHING

- **SEDIMENTATION CLARIFIERS**
- **VERTICAL PRESSURE FILTERS**
- **NOT REQUIRED WITH PRESSURE DISC FILTERS**

LIME MUD WASHER PROBLEMS

- **CLOUDY OVERFLOW**
  - **Over Liming, Fresh Lime, Scrubber Dust, Contaminated Condensate.**
- **LOW UNDERFLOW SOLIDS**
  - **Over Liming, Fresh Lime, U/Flow Pumping**
- **HIGH SODA IN WEAK WASH AND LIME MUD**
  - **Water Balance, U/Flow Pumping**
- **TOO MUCH WEAK WASH**
  - **Water Balance**

LIME MUD PRECOAT DRUM FILTER

Photo courtesy of Dorr-Oliver Eimco

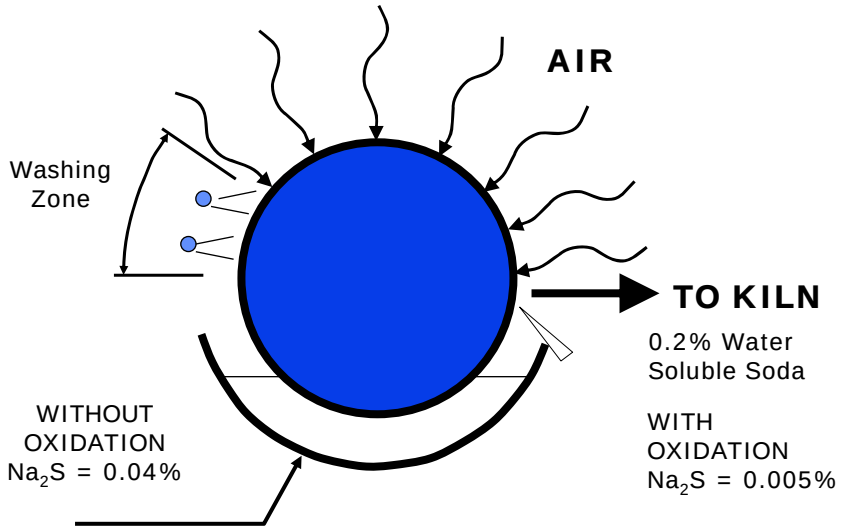
LIME MUD PRECOAT DISC FILTER

Photo courtesy of Dorr-Oliver Eimco

LIME MUD FILTER PROBLEMS

- **HIGH MOISTURE IN KILN FEED**
  - **Over Liming, Fresh Lime, Dregs, Overloaded**
- **FREQUENT PRECOAT CHANGES**
  - **Blinding of Precoat**
    - **Over Liming, Fresh Lime, Dregs, Wash Water**
- **HIGH SODA IN KILN FEED**
  - **Cake Wash, High Moisture**
- **TRS EMISSIONS FROM KILN**
  - **Cake Wash, Overloaded**

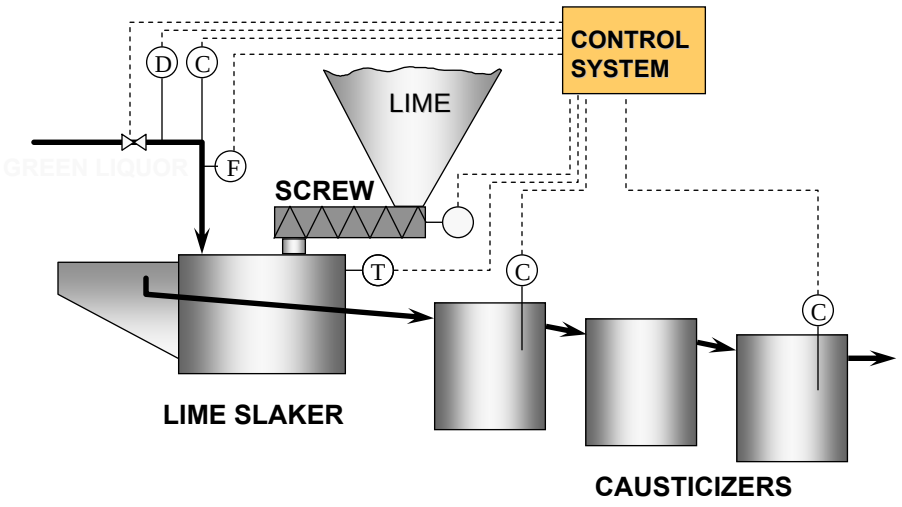
TRS Control via Mud Dewatering & Oxidation



CONTROLS

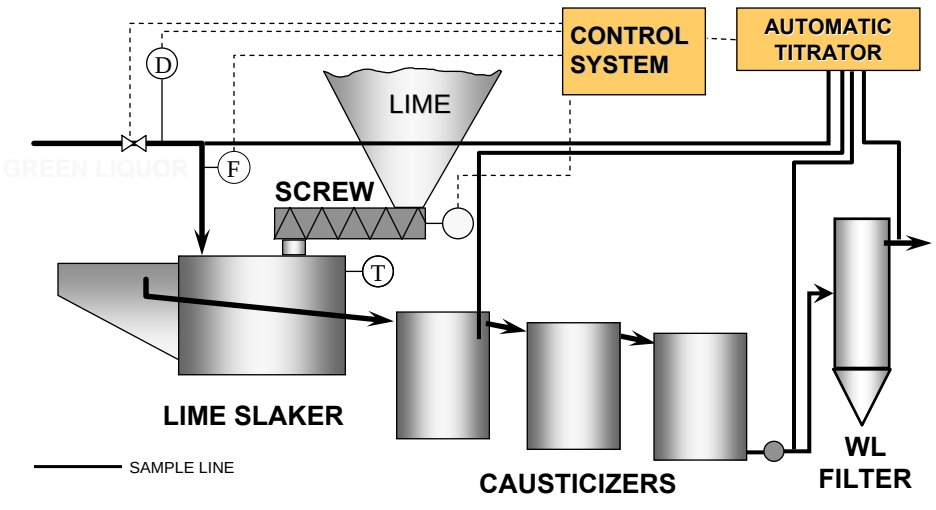
- **CAUSTICIZING CONTROL**
  - **Conductivity**
  - **On-Line Titration**
  - **Near Infrared Spectrometry**
- **GREEN LIQUOR TEMPERATURE AND DENSITY**
- **LIME MUD DENSITY CONTROL**

SLAKER CONTROL



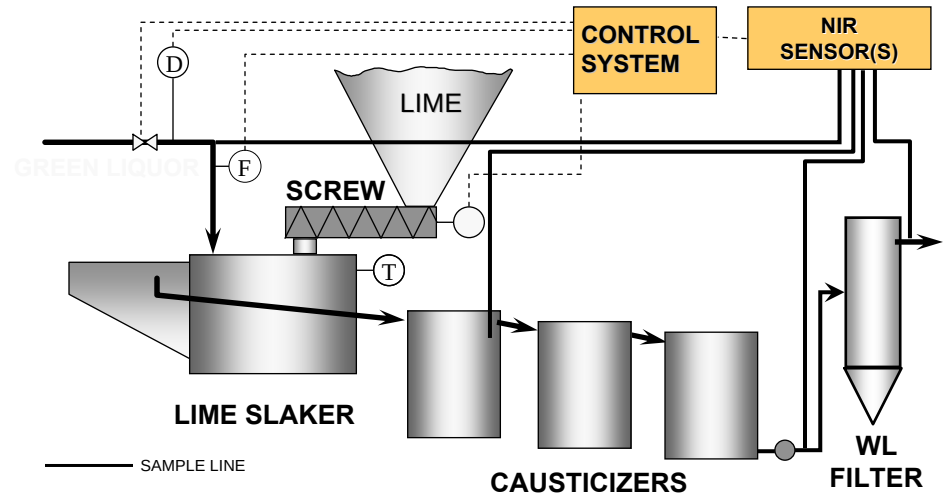
CONDUCTIVITY BASED CONTROL SYSTEM

SLAKER CONTROL



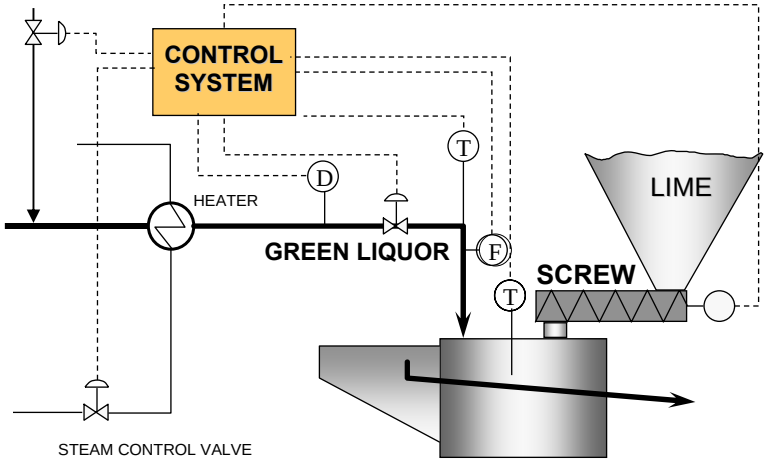
TITRATION BASED CONTROL SYSTEM

SLAKER CONTROL



NEAR-INFRARED BASED CONTROL SYSTEM

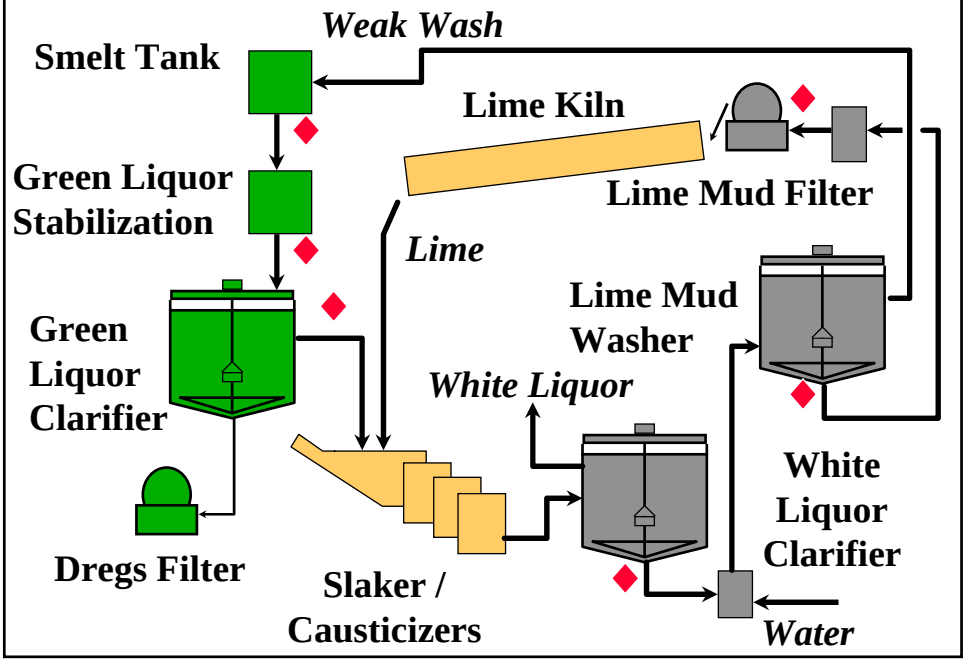
SLAKER CONTROL



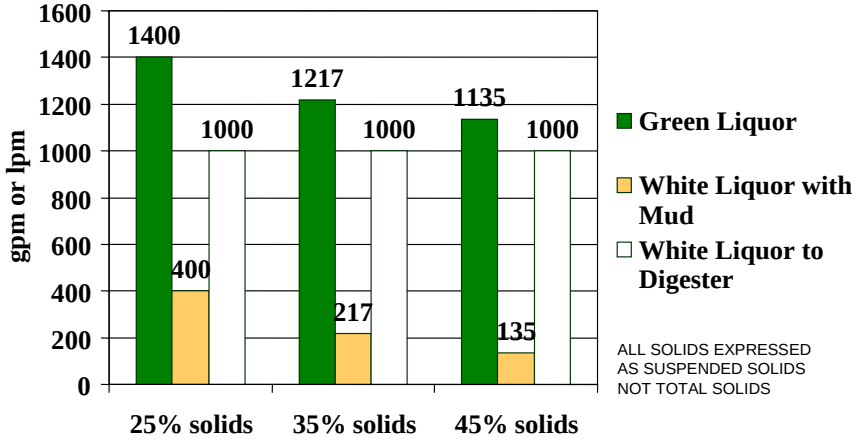
ΔT SLAKER CONTROL AND GREEN LIQUOR DENSITY

LIME SLAKER

DENSITY CONTROL LOCATIONS



EFFECT OF DENSITY CONTROL ON WHITE LIQUOR CLARIFIER UNDERFLOW BASED ON 1000 GPM OR LPM TO DIGESTER



OTHER TECHNOLOGIES

- **PRESSURE GREEN LIQUOR FILTERS**
- **FILTER PRESS FOR DREGS DEWATERING**

SUMMARY

WHAT IS IMPORTANT?

- **GOOD GREEN LIQUOR**
  - **Raw Green Liquor Stabilization Tank**
  - **Conservatively Sized Clarifier**
  - **Density and temperature control**
- **DO NOT OVERLIME**
  - **Causticizing Control**
  - **Fresh Lime Make-up.**

CONCLUSION

FOR TROUBLE FREE OPERATION

- **ADEQUATELY SIZED EQUIPMENT**
- **GOOD GREEN LIQUOR QUALITY**
- **GOOD LIME QUALITY**
- **EFFECTIVE CAUSTICIZING CONTROL**
  - **Slaker and Density controls**
- **LIME MUD WASHING**