TAPPI KRAFT RECOVERY SHORT COURSE

RECAUSTICIZING

CHAPTER 2.1 - PRINCIPLES AND PRACTICE
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TOPICS

• BASIC CHEMISTRY
• FLOWSHEET OPTIONS
• GREEN LIQUOR PREPARATION
• WHITE LIQUOR PREPARATION
• LIME MUD WASHING
• CONTROLS
RECAUSTICIZING CYCLE

GREEN LIQUOR CLARIFICATION

DREGS

SLAKER / CAUSTICIZERS

GREEN LIQUOR

LIME KILN

WEAK WASH

LIME MUD

LIME MUD WASHING

LIME

GREEN LIQUOR

WHITE LIQUOR CLARIFICATION

WHITE LIQUOR

BASIC CHEMISTRY

GREEN LIQUOR + LIME = WHITE LIQUOR + LIME MUD

Na₂CO₃ + H₂O + CaO = 2NaOH + CaCO₃
CHEMICAL REACTIONS

• SLAKING
CaO + H₂O → Ca(OH)₂ + Heat

• CAUSTICIZING
Ca(OH)₂ + Na₂CO₃ ⇌ 2NaOH + CaCO₃

OVERALL REACTION

Na₂CO₃ + H₂O + CaO ⇌ 2NaOH + CaCO₃

• EQUILIBRIUM REACTION
• REVERSIBLE
• INCOMPLETE
REACTION AT SOLID/LIQUID INTERFACE

DEFINITIONS

TTA = TOTAL TITRATABLE ALKALI
NaOH + Na₂S + Na₂CO₃

AA = ACTIVE ALKALI
NaOH + Na₂S

EA = EFFECTIVE ALKALI
NaOH + ½ Na₂S

SULFIDITY %
Na₂S / AA or Na₂S / TTA
DEFINITIONS

CE = CAUSTICITY %
   \[ \frac{NaOH \times 100}{NaOH + Na_2CO_3} \]

Lime Availability %
   \[ \frac{CaO}{Kiln \ Product} \]

Note: All chemical concentrations are expressed on a Na₂O basis e.g. TTA = 120 g/l as Na₂O

Other units of measure are lb/ft³ & lb/gal

OPERATING CAUSTICIZING EFFICIENCY

[Graph showing the relationship between TTA g/l and % CE for different levels of Sulfidity (0%, 15%, 30%)]

Operating CE
FREE CaO vs CAUSTICITY

% FREE LIME vs % CAUSTICITY

FLOWSHEET WITH CLARIFIERS

- Smelt Tank
- Green Liquor Stabilization
- Green Liquor Clarifier
- Dregs Filter
- Slaker / Causticizers
- Lime Kiln
- Lime Mud Filter
- Lime Mud Washer
- White Liquor Clarifier
- White Liquor
- Weak Wash
- Lime
- Water
GREEN LIQUOR PREPARATION

Smelt

Weak Wash

Stabilization Tank

Clariﬁed Green Liquor

Smelt Dissolving Tank

Dregs Filter

Dregs Holding Tank

Variation in Green Liquor Density or Temperature in Stabilization Tank

Density or Temperature

Time

Inlet

Outlet
RAW GREEN LIQUOR STABILIZATION TANK

- RAW GREEN LIQUOR
- TOP MOUNTED AGITATOR
- INLET PIPE
- DOWN COMER
- OPTIONAL SIDE MOUNT AGITATOR
- PUMP TO GREEN LIQUOR CLARIFIER

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!

GREENT 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

Green Liquor
Lime

Grit

Lime Slaker

Causticizers

Clarifier

Lime Mud

LIME SLAKER

GREEN LIQUOR

LIME

TO VENT SCRUBBER

OVERFLOW TROUGH

SECONDARY GREEN LIQUOR FEED

GRIT

TO CAUSTICIZERS

SLAKING COMPARTMENT

CLASSIFIER COMPARTMENT
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**

**Single Silo**

**Two Silos**

- Reburned
- Fresh

From Kiln
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

INLET

OUTLET

INLET

OUTLET

RISER PIPE

WHITE LIQUOR CLARIFICATION

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

[Diagram showing flow and components related to white liquor clarification]
**WHITE LIQUOR CLARIFIER PROBLEMS**

- Pumping Rate

\[
Q_{\text{UF}} = Q_S + Q_L + Q_D
\]

- 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

FILTRATION CYCLE
Filter 3-5 mins
Backwash 3-5 secs
Rest 25-35 secs

FROM CAUSTICIZERS

FEED TANK

A B

D F

TO LIME MUD WASHER (WEAK WASH FILTER)

MUD TANK

WATER

WHITE LIQUOR TO STORAGE TANK

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

FROM CAUSTICIZERS

FEED TANK

COMPRESSOR

CAKE WASH WATER

WHITE LIQUOR SEPARATOR

WATER

LIME MUD SLURRY TANK

TO LIME MUD STORAGE

LIQUOR YIELD

<table>
<thead>
<tr>
<th></th>
<th>White Liquor with Mud</th>
<th>White Liquor to Digester</th>
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<tbody>
<tr>
<td>Causticized Slurry</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Gravity System (35% Solids)</td>
<td>82.1</td>
<td>17.9</td>
</tr>
<tr>
<td>Disc Filter System (75% Solids)</td>
<td>96.8</td>
<td>3.2</td>
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</tbody>
</table>
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

![Image of a 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

AIR

Washing Zone

TO KILN

0.2% Water Soluble Soda

WITHOUT OXIDATION
Na₂S = 0.04%

WITH OXIDATION
Na₂S = 0.005%

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

AT SLAKER CONTROL AND GREEN LIQUOR DENSITY
DENSITY CONTROL LOCATIONS

Smelt Tank
Green Liquor Stabilization
Green Liquor Clarifier
Dregs Filter

Weak Wash
Lime Kiln
Lime Mud Filter
Lime Mud Washer
White Liquor
White Liquor to Digester
Water

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

All solids expressed as suspended solids, not total solids.
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