Optimizing SW ECF Bleaching Technologies with a Poor Man’s O
Oxygen Delignification

Chemical Usage of North American Bleach Plants

Improved environmental and operating cost performance
O Delignification: Background

Literature
- 1960/70s
  - basic engineering & chemistry
- 1980/early 90s
  - process parameters, energy, environmental, pretreatments, fundamental chemistry, pulp properties
- Late 1990’s
  - yield, selectivity, process parameters, lignin/carbohydrate chemistry, catalysts
Oxygen Delignification

Increased interest in one and two-stage oxygen delignification

Yield and Operating Benefits
An Alternative Approach

- **Mini-O**
  - Removes less lignin
  - Less capital
  - Easily retrofitted

- **Enhanced Mini-O**
  - Greater lignin removal
  - Multiple stages
  - $\text{H}_2\text{O}_2$ and/or $\text{ClO}_2$
Mill Application

• McKenzie
  – Cook to normal target
    • Reduce lignin with $\text{O}_2$
  – Sodium hydroxide instead of oxidized white liquor

• Low AOX pulps
  – No production loss
  – No recovery bottleneck
  – 25% delignification
Recent Studies

- Chakar, et al.
  - Compared O systems
    - O, OO, mini-O
  - Split the caustic charge in a (E+O)D(E+O)
  - Delignification
    - Lowest for mini-O
      - 13-25%, depending on caustic addition
Recent Studies

- Chakar, et al.
  - Viscosities
    - O vs. (E+O)D(E+O)
      - Same delignification at 3.5% as O at 1.5%
    - Improved viscosity
Recent Studies

- Chakar, et al
  - Does not mimic actual bleach plant conditions
  - Need to investigate impact of interstage washing and carryover on mini-O system
Delignification Results
Mini-O Delignification Studies

Research Objective

- Examine impact of carryover
- 26.3 Kappa SW kraft
- Determine
  - Physical properties
  - Selectivity

- Contribute to future mini O-delignification road map to improve performance
## Mini-O Delignification: Experimental Design

<table>
<thead>
<tr>
<th>Bleaching Sequences</th>
<th>BL Carryover</th>
</tr>
</thead>
<tbody>
<tr>
<td>(E+O)(E+O)</td>
<td>No carryover</td>
</tr>
<tr>
<td>D(E+O)</td>
<td>2 kg/ton</td>
</tr>
<tr>
<td>(E+O)D(E+O)</td>
<td>10 kg/ton</td>
</tr>
<tr>
<td>D(E+O)(E+O)</td>
<td></td>
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</tbody>
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### Experimental Conditions

<table>
<thead>
<tr>
<th>Stage</th>
<th>O-Press./psi</th>
<th>% NaOH</th>
<th>Temp./°C</th>
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<td>(E+O)</td>
<td>90</td>
<td>1.25</td>
<td>80</td>
<td>20</td>
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<tr>
<td>D₀.05, 0.20</td>
<td>-</td>
<td>-</td>
<td>70</td>
<td>30</td>
</tr>
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<td>(E+O)D(E+O)</td>
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<td>1.25/0/1.25</td>
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10% consistency

MgSO₄: 0.10%
Impact of Carryover

- Carryover decreases delignification
- Increased levels
  - Decreased response
- Splitting (E+O)
  - Improved response
Impact of Carryover

- Viscosity loss
  - Increases as function of carryover

- Carryover
  - May introduce transition metals

- Placement of (E+O)
  - Affects viscosity loss

![Bar chart showing impact of carryover on viscosity loss.]
Impact of Carryover

- Selectivity
  - Decreases as function of carryover

- Carryover
  - May introduce transition metals

- Placement of (E+O)
  - Affects selectivity
Mini-O with H$_2$O$_2$ Studies

Research Objective

- Examine impact of carryover
- Three SW kraft pulps
  - 26.3 Kappa pre-O$_2$
  - 24.3 Kappa pre-O$_2$
  - 8.9 Kappa post-O$_2$
- Determine
  - Physical properties
  - Selectivity
- Contribute to future mini O-delignification road map to minimize capital and enhance performance
## Mini-O with $\text{H}_2\text{O}_2$ Delignification: Experimental Design

### Bleaching Sequences
- O
- D(E+O)
- D(E+O+P)
- (E+O)*D(E+O)*
- D(E+O)*(E+O)*

### Pulps
- Pre-Oxygen
  - 26.3 kappa
- Pre-Oxygen
  - 24.2 kappa
- Post-Oxygen
  - 8.9 kappa
## Experimental Conditions

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<tr>
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10% consistency  BL carryover: 10 kg/ton

$H_2O_2 : 0.5\%$  MgSO$_4$: 0.10\%
Mini-O Reinforced with H₂O₂

- Carryover at 10 kg/ton
  - Decreased response

- Pre-O₂ vs. Post-O₂
  - Decreased response in post-O₂

- Delig. Response
  - Proportional to H₂O₂

- \((EO)*D_{0.05}(EO)\)*
Mini-O Reinforced with H$_2$O$_2$

- Carryover at 10 kg/ton
  - Generally decreases viscosity loss

- Pre-O$_2$ vs. Post-O$_2$
  - Greater loss for pre-O$_2$ pulp

- Increased H$_2$O$_2$
  - Increased viscosity loss
Mini-O Reinforced with H$_2$O$_2$

- Carryover at 10 kg/ton
  - Generally decreases selectivity

- Pre-O$_2$ vs. Post-O$_2$
  - Greater selectivity for pre-O$_2$ pulp
Mini-O Reinforced with $\text{H}_2\text{O}_2$

- Carryover at 10 kg/ton
  - Generally decreases brightness response

- (EO) vs. (EOP)
  - Exiting bleaching stage
Conclusions
Mini-O Delignification: Implications

- Promising technology

- Superior performance with pre-O\textsubscript{2} pulps when compared to post-O\textsubscript{2} pulps

- Benefits of enhanced poor man’s O

- H\textsubscript{2}O\textsubscript{2} in last stage of (EO)*D(EO)*
  - Increased bleaching performance
Acknowledgments

IPST Member Companies

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