Optimizing the Bleaching of Georgia’s SW Thinning Kraft Pulp Resource

Program Review

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Optimizing the Pulping and Bleaching of Georgia’s SW Thinning Wood Resource: Background

• Georgia has the highest collection of non-industrial private forest landowners (NIPF) in the nation
• NIPF are a primary source of wood for many of Georgia’s pulp mills.
• NIPF owners have begun to utilize short-rotation management options to improve the feasibility, profitability, and cash flow of production forestry enterprises.
• A valuable component in forestry management approaches is to cut immature trees to stimulate growth/yield of the remaining trees
• University of Georgia have demonstrated that thinning loblolly and slash pine stands increased internal rate of return for NIPF landowners by 1½% (slash) to 2% (loblolly) over unthinned stands.
• Hence economical factors will increase the availability of pine thinnings for kraft pulping operations
• Potential cost savings of 15 – 30%
Optimizing the Pulping and Bleaching of Georgia’s SW Thinning Wood Resource: Background

- The performance of Georgia’s pine thinnings for bleached kraft pulps have not been reported.

- Literature results document differences in kraft pulping for thinnings versus mature wood for:
  - Black, norway, radiate pine, red and white spruce
  - FY 2002 – 2003 GA TIP3 documented for GA SW Kraft
  - Wood (M:T)
    - Density: 1.00:1.04, Klason Lignin: 1:00:1.04, Glucose: 1:04:1:1.00
  - Kraft Pulp (M vs.T)
    - Yield: 45.63 - 44.63, Kappa #: 24.2 – 27.4
    - Tensile Index: 88.2 – 89.6, Tear Index: 16.8 – 13.6 (after 4000 PFI rev)
    - Differences greater than some northern species
    - Experimental results between 40:60 and 60:40 blends of Thinning and Mature are very small and would most likely not be observed in commercial practice
    - Need to quantify results after bleaching
Optimizing the Pulping and Bleaching of Georgia’s SW Thinning Wood Resource: Program/GA Mill Objectives

Research Program Objective:

Assess the impact of SW thinnings for the production of bleached kraft pulp for Georgia’s pulp mill operations.

FY 2002 – 03: Examined SW kraft pulps
FY 2003 – 04: Examine ECF bleached SW kraft pulps

This program will provide Georgia’s pulp mills with valuable operational information so that they can manufacture a high-value, quality product at the lowest cost possible using the states pine wood thinnings at the completion of FY 2003 – 04 studies.
Experimental Objectives:

- Kraft Cooking Process
- Ratio of Thinnings:Mature Wood Employed
- Conventional batch 100:0, 80:20, 40:60, 0:100
- Simulated ITC 100:0, 60:40, 0:100

The kraft pulps will be bleached to TAPPI brightness ~85 via two bleaching sequences:

1. \( OD(E+P+O)D \)
2. \( D(E+P+O)DED \)

- The partially bleached pulps will be analyzed for kappa number, viscosity, and TAPPI brightness
- The fully bleached pulps will be analyzed for optical, chemical, and physical strength properties
- Fully bleached pulps will also be PFI refined with 2000, and 4,000 revs and the physical strength properties will be re-assessed at each point of refining
Optimizing the Bleaching of Georgia’s SW Thinning Wood Resource: Experimental Protocol

OD(E+P+O)D

O-Stage (Incoming brownstock kappa # 24-27)
- 60 min, 100°C, 10% csc, 90 psig O₂
- Caustic charge varied 1.0 – 1.8
  - preferred value ~1.5% NaOH to yield post-O kraft pulps with kappa # ~ 10

- D₀-Stage
  - 45 min, 50°C, 3.5% csc, Kf 0.25, terminal pH 2.1 – 2.3

- (E+P+O)-Stage
  - 60 min, 75°C, 10% csc, 0.4% H₂O₂, initial O₂:65 psig 15 min; then vent12 psig/5 min, %NaOH 50% of Kf

- D₁-Stage
  - 180 min, 75°C, 10% csc, ClO₂ charge 0.5 – 2.0%, terminal pH 3
  - Final TAPPI Brightness Values ~ 87
Optimizing the Bleaching of Georgia’s SW Thinning Wood Resource: Results

<table>
<thead>
<tr>
<th></th>
<th>Conventional</th>
<th>ITC</th>
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<tbody>
<tr>
<td>Mature</td>
<td>87.6</td>
<td>87.2</td>
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<tr>
<td>Thinning</td>
<td>87.2</td>
<td>87.5</td>
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<tr>
<td>60% Thin/40% Mature</td>
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<td>87.4</td>
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<td>40% Thin/60% Mature</td>
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<tr>
<td>80% Thin/20% Mature</td>
<td>87.7</td>
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Optimizing the Bleaching of Georgia’s SW Thinning Wood Resource: Results

OD(E+O+P)D Fiber Properties: Fiber Length

ITC
Optimizing the Bleaching of Georgia’s SW Thinning Wood Resource: Results

OD(E+O+P)D Fiber Properties: Fiber Length

Conventional
Optimizing the Bleaching of Georgia’s SW Thinning Wood Resource: Results

OD(E+O+P)D Fiber Properties: Fines

![Bar chart showing % fines (arithmetic) for different stages of thinning and mature stages.](chart.png)
Optimizing the Bleaching of Georgia’s SW Thinning Wood Resource: Results

OD(E+O+P)D Fiber Properties: Fiber Charge

![Graph showing mmol Acid group/gr pulp for different wood samples, including ITC: Mature, ITC: 60% Thinning, ITC: Thinning, Thinning, 40% Thin, 80% Thin, and Mature.](image-url)
Optimizing the Bleaching of Georgia’s SW Thinning Wood Resource: Results

O(D+P+O)D Sheet Properties
Optimizing the Bleaching of Georgia’s SW Thinning Wood Resource: Results

Sheet Properties: Conventional Kraft Pulps
Optimizing the Bleaching of Georgia’s SW Thinning Wood Resource: Results

Sheet Properties: Conventional Kraft Pulps
Optimizing the Bleaching of Georgia’s SW Thinning Wood Resource: Results

Sheet Properties: Conventional Kraft Pulps
Optimizing the Bleaching of Georgia’s SW Thinning Wood Resource: Experimental Protocol

D(E+P+O)DED

• **D₀-Stage** (*Incoming brownstock kappa # 24-27*)
  - K.f.:0.20, 45 min, 50°C, 3.5% csc, terminal pH: 1.8

• **(E+P+O)-Stage**
  - 60 min, 90°C, 10% csc, 0.4% H₂O₂, initial O₂:35 psig 15 min; then vent 12 psig/5 min, 3.2 %NaOH

• **D₁-Stage**
  - 180 min, 75°C, 10% csc, 1.0% ClO₂, terminal pH 3

• **E-Stage**
  - 60 min, 75°C, 10% csc, 0.5% NaOH, terminal pH 12

• **D₂-Stage**
  - 180 min, 75°C, 10% csc, 0.2% ClO₂, terminal pH 3

• Final TAPPI Brightness Values ~ 88
Optimizing the Bleaching of Georgia’s SW Thinning Wood Resource: Results

D(E+P+O)DED TAPPI Brightness Properties

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<td>Mature</td>
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<td>60% Thin/40% Mature</td>
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Pulp Viscosity Properties (mPa.s)

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<th>Conventional D(EPO)DED</th>
<th>ITC D(EPO)DED</th>
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<tr>
<td>Thinning</td>
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<td>60% Thin/40% Mature</td>
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<td>40% Thin/60% Mature</td>
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<tr>
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<td>23.1</td>
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Physical Strength Properties Evaluated After 0, 2000, and 4000 revs PFI refining
Optimizing the Bleaching of Georgia’s SW Thinning Wood Resource: Results

D(E+O+P)DED Fiber Properties: Fiber Length
Optimizing the Bleaching of Georgia’s SW Thinning Wood Resource: Results

D(E+O+P)DED Fiber Properties: Tensile Index
Optimizing the Bleaching of Georgia’s SW Thinning Wood Resource: Results

D(E+O+P)DED Fiber Properties: Burst Index
Optimizing the Bleaching of Georgia’s SW Thinning Wood Resource: Results

D(E+O+P)DED Fiber Properties: Tear Index
Optimizing the Bleaching of Georgia’s SW Thinning Wood Resource: Results

D(E+O+P)DED Fiber Properties: Dry Zero Span
Optimizing the Bleaching of Georgia’s SW Thinning Wood Resource: Results

D(E+O+P)DED Fiber Properties: Wet Zero Span
Optimizing the Bleaching of Georgia’s SW Thinning Wood Resource

Conclusions:

• Observe distinct differences in Thin. vs. Mature wood and kraft pulp samples are maintained in fully bleached pulps

• Trends observed for conventional kraft pulps observed in continuous kraft

• Differences in tensile vs. tear larger than some northern species
Conclusions:

• Experimental results between 40:60 and 60:40 blends of Thinning and Mature are very small and would most likely not be observed in commercial practice.

Depending on product grade thinnings will provide distinct cost saving with little impact on product performance.
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Acknowledgements

GA TIP3