Optimized ECF
Bleaching Sequence Studies
Softwood Kraft Brownstock

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**Project Goals**

Sequences Examine

D/C(EO)DED*  OD(EOP)D*
D/Z(EOP)DED  OZ/D(PHT)D
ZQ(PHT)Z(PHT)  OZ(PHT)D
OZQ(PHT)  OZQ(PHT)Z(PHT)

-softwood
Results D/C(EO)DED: Softwood Bleaching Conditions

D/C - 50% ClO2 Substitution
KF 0.20, SW Kappa# 33.3
10% Black liquor carryover
3.5% csc, 50°C, 45 min.

EO - 3.6% NaOH, 75°C, 75 min
O2=35 psi 15 min, 10% carryover

D1 - 1.0% ClO2, 75°C, 180 min
10% carryover, 10% csc

E - 75°C, 60 min, 10% carryover, 10%csc
0.5% NaOH

D2
0.4%, 0.6%, 0.8%, 1.0% ClO2
75°C, 180 min., 10% csc
Results D/C(EO)DED: Softwood Bleaching Results

TAPPI Brightness

- D/C
- (EO)
- D1
- D2 (0.4%)
- D2 (0.6%)
- D2 (0.8%)
- D2 (1.0%)
Results OD(EOP)D: Softwood Bleaching Conditions

- **02** - initial washed kappa # 30.4 carryover
  - 2.0% NaOH, 110°C
  - 30 min, 60 psi O2

- **D1** - 0.22 KF (incoming kappa# = 15.0)
  - O2 = 35 psi 15 min, 10% carryover
  - 50°C, 60 min

- **(EOP)** - 1.82% NaOH, 0.4% H2O2
  - 90°C, 60 min., 10% carryover
  - 35 psi O2/15min

- **D2** - 75°C, 180 min, 10% carryover, 10%csc
  - 0.6%, 0.8%, 1.0%, 1.2% ClO2

- **D2**
  - 0.4%, 0.6%, 0.8%, 1.0% ClO2
  - 75°C, 180 min., 10% csc
Results OD(EOP)D: Softwood Bleaching Results

- TAPPI Brightness
- D1
- (EOP)
- D2 (0.6%)
- D2 (0.8%)
- D2 (1.0%)
- D2 (1.2%)
Results OD(EOP)D: Softwood Bleaching Results

![Bar chart showing TAPPI Brightness results for different concentrations of D2 and D.](chart.png)

- **D2 (0.6%)**
- **D2 (0.6%) D (0.25%)**
- **D2 (0.6%) D (0.5%)**
- **D2 (0.8%)**
- **D2 (0.8%) D (0.25%)**
- **D2 (0.8%) D (0.5%)**
- **D2 (1.0%)**
- **D2 (1.0%) D (0.25%)**
- **D2 (1.0%) D (0.5%)**
- **D2 (1.2%)**
- **D2 (1.2%) D (0.25%)**
- **D2 (1.2%) D (0.5%)**
Results (D/Z) vs. (Z/D):
Softwood before O2

- General Bleaching Conditions
  - 50°C
  - 0.20 KF
    » 50% Z subst.
    » pH\text{initial} \cdot 2.5
    » 10% carryover
Results (D/Z) vs. (Z/D) at 3.5% CSC:
Softwood before O2
Results (D/Z) vs. (Z/D) at 10% CSC: Softwood before O2
Research Issues

- Direction on D/Z
  - pre-O2 >> D/Z
  - post-O2 >> Z/D
- Secondary Z stages to be at 10% csc
- Brightness target
  - OD(EOP)DD
Studies Directed on
D/Z(EOP)DED & D/Z(EOP)Z/D(EP)D

- **D/Z(EOP)DED**
  - D/Z 0.2 kf
    - 50% Z sub
  - EOP
    - 0.4 & 0.8% P
  - D1 0.8% charge
  - E
  - D2
    - 0.2, 0.4, 0.6, 0.8% charge

- **D/Z(EOP)Z/D(EP)D**
  - D/Z 0.2 kf
    - 50% Z sub
  - EOP
    - 0.5 & 1.0% P
  - Z/D
    - 0.2% consumed
    - 0.5% ClO₂
  - D2
    - 0.2, 0.4, 0.8% ClO₂
Kappa and ISO Brightness After D/Z (0.20 kf, 50% Sub., 50C, 10kg/ton carryover) & Eop (%NaOH=0.5 TAC, 90C, 10% carryover, 20 psi O2 at 15 min, 0 psi at 60 min)
Brightness Changes for Bleaching Four (D/Z)(EOP) Pulps with DED

D₁ employed 0.8% ClO₂ and D₂ employed either 0.6% or 0.8% ClO₂.
Brightness Changes for Bleaching (D/Z)(EOP) Pulps with DED

D1 employed 1.2% ClO2 and D2 employed either 0.6% or 0.8% ClO2

<table>
<thead>
<tr>
<th>Bleaching Stage</th>
<th>ISO Brightness</th>
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<tbody>
<tr>
<td>(D1 Charge= 1.2% ClO2)E</td>
<td>D2 Charge=0.6% ClO2</td>
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<tr>
<td>Eop 0.5% P</td>
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<tr>
<td>Eop 1.0% P</td>
<td></td>
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</tbody>
</table>
Studies Directed on

OZ(PHT)D & OZQ(PHT)Z(PHT)

- **OZ(PHT)D**
  - Z
    » 0.3 & 0.5% Z consumed
  - PHT
    » 1.0 & 2.0% P
  - D
    » 0.2, 0.4, 0.6, 0.8%

- **OZQ(PHT)**
  - Z
    » 0.3% consumed
  - PHT
    » 1.0 & 2.0% P

- **OZQ(PHT)Z(PHT)**
  - Z
    » 0.3% Z consumed
  - Q
  - PHT
    » 1.0 2.0% P
  - Z
    » 0.3% Z consumed
  - PHT
    » 1.0, 1.5% P
OZ(PHT)Z(PHT) Studies

- O-stage
- Z-stage - 0.3% consumed, pH 2.2
  - 50C
- Q - DTPA
  - 1.0% H₂O₂ - 1.3% NaOH
    - term. pH 9.4
    - ISO bright. 42.3
  - 2.0% H₂O₂ - 2.6% NaOH
    - term. pH 9.4
    - ISO bright. 46.1
- Z-stage 0.3% consumed pH 2.2
  - 1.5% H₂O₂ - 2.0% NaOH
    - term. pH 9.2
    - ISO brightness 70
OZ(PHT)D Studies

1. O-stage
2. Z-stage
   - 0.3% consumed, pH 2.2
   - 50C
3. 1.0% H₂O₂ - 1.0% NaOH
   - term. pH 9.2
   - ISO bright. 41.3
4. 2.0% H₂O₂ - 2.0% NaOH
   - term. pH 9.2
   - ISO bright. 43.6