

*EMERGING TECHNOLOGIES:
HOW TO MAKE THE NEW WHITE
(AND TO BE INCIDENTALY HAPPY)*

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BY

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ZOIA COMPANY

RIOCELL S.A.

BRAZIL

AND

ANA SABINA CAMPOS

*WHITE MARTIN'S GASES INDUSTRIAIS
BRAZIL*

*WHEN YOU ARE IN THE
FRONTIER OF THE
KNOWLEDGE ...*

*YOU SHOULD NOT CONSIDER
THAT THE DAY AFTER WILL
FOLLOW THE TODAY'S
PATTERN*

OR BETTER SAYING

EVERYTHING IS ALLOWED

THUS, ...

*WE REALLY HAVE LOTS OF
QUESTIONS TO BE ANSWERED*

BY US

OR

BY SOMEBODY ELSE

QUESTION 1:

*IS IT POSSIBLE TO BLEACH TO
ROUGHLY 89-90% ISO BRIGHTNESS
WITH GOOD STABILITY AND OTHER
OVERALL PROPERTIES WITHOUT THE
USE OF CHLORINATED COMPOUNDS?*

QUESTION 2:

IS BLEACHING AN INDIVIDUALIZED OPERATION OR IS IT WELL CONNECTED TO THE OTHER KRAFT PULPING OPERATIONS?

QUESTION 3:

IS IT TRUE THAT

ENZYMES

CHELANTS

PEROXYDES

OXYGEN

CAUSTIC SODA

*COULD GIVE ME A PULP AS WHITE AS
IT'S MANUFACTURED TODAY?*

QUESTION 4:

*DOES IT MAKE SENSE TO GO TO
EXTENDED DELIGNIFICATION AT
THE DIGESTER?*

**EMCC PERFORMANCE (FINAL
BLEACHED PULP)**

| | |
|-----------------------|--------------------------|
| Δ BRIGHTNESS | = +2% ISO |
| Δ REVERTED BRIGHTNESS | = +2% ISO |
| Δ POST COLOR NUMBER | = -0.18 |
| Δ INTRINSIC VISCOSITY | = +55 cm ³ /g |
| Δ S ₅ | = -0.63% |

IN COMPARISON TO STANDARD COOKING

QUESTION 5:

*DOES IT PAY GOING TO MORE
DRASTIC CONDITIONS AT THE
OXYGEN DELIGNIFICATION?*

DRASTIC OXYGEN DELIGNIFICATION
PERFORMANCE IN COMPARISON TO STANDARD
PROCEDURE

| | |
|-----------------------|--------------------------|
| △ BRIGHTNESS | = +2.3% ISO |
| △ REVERTED BRIGHTNESS | = +2.5% ISO |
| △ POST COLOR NUMBER | = -0.22 |
| △ INTRINSIC VISCOSITY | = +26 cm ³ /g |
| △ S ₅ | = -0.34% |

QUESTION 6:

*DOES IT MAKE SENSE TO USE
CHELANTING AGENTS BEFORE
BLEACHING?*

WHAT ABOUT ENZYMES?

**PERFORMANCE OF CHELANT IN
COMPARISON TO ACID WASHING**

| | |
|-----------------------|-------------------------|
| △ BRIGHTNESS | = +1% ISO |
| △ REVERTED BRIGHTNESS | = +1.1% ISO |
| △ POST COLOR NUMBER | = -0.08 |
| △ INTRINSIC VISCOSITY | = +8 cm ³ /g |
| △ S ₅ | = -0.08% |

**PERFORMANCE OF XYLANASE IN
COMPARISON TO ACID WASHING**

| | |
|------------------------------|------------------------------|
| Δ BRIGHTNESS | = +1.6% ISO |
| Δ REVERTED BRIGHTNESS | = +1.6% ISO |
| Δ POST COLOR NUMBER | = -0.09 |
| Δ INTRINSIC VISCOSITY | = -6 cm³/g |
| Δ S₅ | = -0.2% |

PERFORMANCE OF XYLANASE PLUS CHELANT
IN COMPARISON TO ACID WASHING

| | |
|------------------------------|-------------------------|
| Δ BRIGHTNESS | = +2.45% ISO |
| Δ REVERTED BRIGHTNESS | = +2.75% ISO |
| Δ POST COLOR NUMBER | = -0.22 |
| Δ INTRINSIC VISCOSITY | = -3 cm ³ /g |
| ΔS_5 | = -0.45% |

QUESTION 7:

*ACID WASHING PRIOR TO BLEACHING ...
DOES IT WORK?*

IT DEPENDS ON

PULP CONTAMINANTS

pH

***AT pH 3.0 REMOVAL OF MANGANESE
REACHES 85% BUT IRON ONLY 50%***

BETTER USING pH BELOW 2.0

QUESTION 8:

***WHAT IS THE ROLE OF AN ENHANCED
CAUSTIC EXTRACTION (WITH OXYGEN)
BETWEEN OZONE STAGES?***

**IT COULD BE CONSIDERED DROPPABLE
IN MOST CASES**

**BETTER TO USE A PEROXIDE STAGE OR
AN (EOP) STAGE**

QUESTION 9:

***SHOULD WE USE OR NOT USE SILICATES
IN PEROXYDE STAGE?***

**IT'S SURELY BETTER, BUT IN SOME CASES,
DISCARDABLE.**

**IT DEPENDS ON HOW EFFICIENT WAS THE
REMOVAL OF METAL IONS AND HOW
AVAILABLE ARE HYDROXYL GROUPS
FROM NaOH.**

QUESTION 10:

***HOW TO GET RID OF METAL IONS IN
THE KRAFT PROCESS CYCLE?***

**BY FILTERING ALKALINE LIQUOR (WHITE
OR GREEN) AS IT HAS BEEN PROPOSED
BY FILTER MANUFACTURERS**

•
•
•

**WE SOLVE PARTIALLY THE PROBLEM
WE STILL NEED BETTER ANSWER**

FILTRATION OF WHITE LIQUOR

FILTERED RESIDUE:

| | |
|--------|-------------------------------------|
| 0.84% | ORGANIC MATTER |
| 5.07% | CARBONATES (BURNT CO ₂) |
| 55.64% | SILICA |
| 30.90% | ANALYSED METAL IONS |
| 7.55% | OTHER IONS, SULFUR, ETC. |

FILTRATION OF WHITE LIQUOR

EFFICIENCY ON REMOVAL OF METAL IONS:

| | |
|------------------|-------------|
| <i>CALCIUM</i> | <i>96%</i> |
| <i>IRON</i> | <i>91%</i> |
| <i>ZINC</i> | <i>63%</i> |
| <i>MANGANESE</i> | <i>16%</i> |
| <i>NICKEL</i> | <i>8%</i> |
| <i>MAGNESIUM</i> | <i>7%</i> |
| <i>COBALT</i> | <i>3.5%</i> |
| <i>COPPER</i> | <i>2.6%</i> |
| <i>ALUMINUM</i> | <i>0.9%</i> |
| <i>CHROMIUM</i> | <i>0.4%</i> |

QUESTION 11:

FINAL Z STAGE

OR

FINAL P STAGE

*WHAT'S BETTER CONSIDERING PULP
BRIGHTNESS STABILITY?*

**IT'S CLEARLY EVIDENT THAT FINAL
Z STAGE BRINGS A LOT MORE
BRIGHTNESS REVERSION.**

**BETTER TO AVOID FINAL Z AND TO
HAVE A P STAGE (EVEN A MILD
ONE) ENDING THE SEQUENCE.**

QUESTION 12:

*DOES SO₂ WASHING AFTER A Z
STAGE HELP AT THE END OF THE
BLEACHING?*

**PERFORMANCE OF SO₂ WASHING AT THE
END OF THE BLEACHING**

| | |
|-----------------------|--------------------------|
| △ BRIGHTNESS | = +0.25% ISO |
| △ REVERTED BRIGHTNESS | = +0.77% ISO |
| △ POST COLOR NUMBER | = -0.17 |
| △ INTRINSIC VISCOSITY | = +10 cm ³ /g |
| △ S ₅ | = -0.02% |

QUESTION 13:

WOULD YOU RECOMMEND TO GO TO THIS WONDERFULL ADVENTURE OF MAKING TCF PULP 89-90% BRIGHTNESS, EVEN CONSIDERING THE RISKS OF A NEW AND GROWING TECHNOLOGY?

***IT'S A NEW WORLD
THERE ARE NO KNOWN-RULES
EVERYTHING IS CHALLENGING US***

BUT REMEMBER

***DON'T LET YOUR COMPANY BROKEN
WE ARE HERE TO MAKE MONEY IN THE
MARKET (AND THE MARKET IS OUR
WEAKER POINT TODAY)***

OTHER QUESTIONS TO BE EVALUATED:

- √ *HOW TO RECYCLE ALL BLEACHING EFFLUENTS?
EFFLUENT FREE BLEACHING*
- √ *HOW TO GET RID OF METAL IONS? DO THEY REALLY
NEED TO BE REMOVED PRIOR TO OZONE STAGE?*
- √ *WHAT HAPPENS TO THE OPTICAL AND TACTILE
SOFTNESS PROPERTIES OF EUCALYPTUS PULPS WHEN
BLEACHED WITH THESE EMERGING TECHNOLOGIES?*

- ✓ **WHAT HAPPENS TO THE PAPERMAKING PROPERTIES OF THE PULPS?**
- ✓ **IS BLEACHING PULP YIELD ACCEPTABLE WHEN USING THESE NEW EMERGING SEQUENCES?**
- ✓ **IS IT POSSIBLE TO USE OXIDIZED WHITE LIQUOR INSTEAD OF CAUSTIC SODA IN BLEACHING? HOW TO IMPROVE IT?**
- ✓ **WHAT'S THE CARRY-OVER EFFECT IN BLEACHING CHEMICAL CONSUMPTION?**
- ✓ **WHAT CONSISTENCY IS BETTER TO PERFORM OZONE STAGE?**

- ✓ *WHAT COULD BE THE BEST BLEACHING SEQUENCE?*
- ✓ *HOW MANY Z STAGES? HOW MANY P STAGES? IN WHICH WAY TO COMBINE THEM?*
- ✓ *WHAT ABOUT Q Z1 Z2 P1 P2 ?*
- ✓ *OR Q Z1 P1 Z2 P2 ?*
- ✓ *HOW TO MAKE TCF PULP AT REASONABLE BLEACHING COSTS? HOW TO SAVE CHEMICALS?*

EXPERIMENTAL

WOOD

BLEND OF

| | |
|--------------------------------|-------|
| <i>Eucalyptus saligna</i> | 72% |
| <i>Eucalyptus tereticornis</i> | 13.5% |
| <i>Acacia mearnsii</i> | 14.5% |

KRAFT PULPING (LAB)

***EXTENDED ISOTHERMAL COOKING
AND
KRAFT BATCH COOKING
(STANDARD PROCEDURE)***

COOKING

| | <u>EMCC</u> | <u>STANDARD BATCH</u> |
|---|-------------|---------------------------|
| ACTIVE ALKALI CONSUMPTION, % | 17.4 | 17.6 |
| SULFIDITY, % | 20 | 20 |
| TIME, min | 300 | 105 |
| MAXIMUM TEMPERATURE, °C | 153 | 170 |
| GROSS YIELD, % | 50.1 | 50.8 |
| REJECTS, % | <0.1 | 0.4 |
| KAPPA NUMBER | 14.4 | 17.8 |
| INTRINSIC VISCOSITY, cm ³ /g | 1273 | 1129 |
| BRIGHTNESS, % ISO | 40.4 | 42.1 |
| S5 - 5% CAUSTIC SOLUBILITY OF PULP, % | 9.3 | 10.4 |

OXYGEN DELIGNIFICATION

TWO DIFFERENT CONDITIONS APPLIED TO BOTH UNBLEACHED PULPS

| | O ₂ STANDARD | DRASTIC O ₂ |
|-------------------------------|-------------------------|------------------------|
| TEMPERATURE, °C | 95 | 105 |
| TIME, min | 45 | 60 |
| % NaOH | 1.5 | 1.8 |
| PRESSURE, kgf/cm ² | 7 | 7 |
| CONSISTENCY | 10 | 10 |

OXYGEN DELIGNIFICATION RESULTS

EMCC PULP

| | <i>O₂ STANDARD</i> | <i>DRASTIC O₂</i> |
|---------------------|-------------------------------|------------------------------|
| FINAL pH | 11.8 | 11.3 |
| KAPPA NUMBER | 10.3($\Delta=28.5\%$) | 7.5($\Delta=47.9\%$) |
| INTRINSIC VISCOSITY | 1151 | 1075 |
| BRIGHTNESS, % ISO | 51.6 | 56.6 |
| S5, % | 9.5 | 9.6 |

STANDARD BATCH

| | <i>O₂ STANDARD</i> | <i>DRASTIC O₂</i> |
|---------------------|-------------------------------|------------------------------|
| FINAL pH | 11.2 | 10.6 |
| KAPPA NUMBER | 12.6($\Delta=29.2\%$) | 10.8($\Delta=39.3\%$) |
| INTRINSIC VISCOSITY | 957 | 841 |
| BRIGHTNESS, % ISO | 53.4 | 58.3 |
| S5, % | 10.0 | 10.0 |

BLEACHING SEQUENCES

OVER THE FOUR DIFFERENT OXYGEN DELIGNIFIED PULPS, THE FOLLOWING BLEACHING SEQUENCES WERE TESTED:

Z P

A Z P

Q Z P

X Z P

X Q Z P

Q Z₁ E₀ Z₂

Q Z₁ E₀ Z₂ SO₂

Q Z₁ (E₀ P') Z₂

Q Z₁ (E₀ P') Z₂ SO₂

Q Z₁ P Z₂

Q Z₁ P Z₂ SO₂

BLEACHING CONDITIONS

A

pH = 3
2% consistency
65 °C
15 minutes

Q

pH = 5 - 6
2% consistency
65 °C
15 minutes
0.2% DTPA

X

2 U xylanase/g
pH = 5
10% consistency
50 °C
90 minutes

BLEACHING CONDITIONS

Z

0.55 - 0.60% ozone
pH = 3
45% consistency
room temperature (30 °C)
2 - 4 minutes

P

1.5% H₂O₂
1.2% NaOH
2.0% silicate
pH = 10.5(initial)
10.3(final)
90 minutes
80 °C

Z₁

same as Z, except
ozone = 0.45 - 0.47%
time = 1 - 2 minutes

BLEACHING CONDITIONS

Z₂

same as Z, except
ozone = 0.15 - 0.17%
time = 20 - 40 seconds

EO

10% consistency
60 minutes
90 °C
3 kgf/cm²
NaOH = 1.5%
pH = 11.4 (initial)
11.2 (final)

BLEACHING CONDITIONS

(EoP')

SIMULATING UP FLOW O₂ AND
DOWN FLOW P TOWERS
NO WASHING BETWEEN EO AND P'

a) Eo

10% consistency
15 minutes
80 °C
3 kgf/cm²
pH = 11.4 (initial)
11.2 (final)

b) P'

same as P, except
H₂O₂ = 1% and
time was 45 minutes

SO₂

5% consistency
15 minutes
room temperature (30°C)
0.25% SO₂

BLEACHING RESULTS: STANDARD BATCH COOKING + STANDARD O₂

| <i>SEQUENCE</i> | <i>BRIGHTNESS</i> | <i>REVERTED BRIGHTNESS</i> | <i>POST COLOR NUMBER</i> | <i>INTRINSIC VISCOSITY</i> | <i>S5</i> |
|---|-------------------|--------------------------------|----------------------------------|--------------------------------|-----------|
| Z P | 81.8 | 78.4 | 0.95 | 525 | 9.3 |
| A Z P | 81.3 | 77.9 | 1.00 | 452 | 9.4 |
| Q Z P | 82.7 | 79.2 | 0.92 | 489 | 9.5 |
| X Z P | 84.0 | 80.0 | 0.98 | 475 | 9.2 |
| X Q Z P | 84.5 | 81.6 | 0.65 | 466 | 9.2 |
| Q Z ₁ E ₀ Z ₂ | 80.1 | 74.5 | 1.90 | 492 | 8.9 |
| Q Z ₁ E ₀ Z ₂ SO ₂ | 80.4 | 74.7 | 1.90 | 511 | 9.0 |
| Q Z ₁ (E ₀ P') Z ₂ | 84.3 | 78.1 | 1.60 | 393 | 9.1 |
| Q Z ₁ (E ₀ P') Z ₂ SO ₂ | 84.5 | 77.6 | 1.80 | 377 | 9.3 |
| Q Z ₁ P Z ₂ | 86.0 | 79.5 | 1.50 | 426 | 9.0 |
| Q Z ₁ P Z ₂ SO ₂ | 86.0 | 79.8 | 1.40 | 483 | 8.8 |

BLEACHING RESULTS: STANDARD BATCH COOKING + DRASTIC O₂

| SEQUENCE | BRIGHTNESS | REVERTED BRIGHTNESS | POST COLOR NUMBER | INTRINSIC VISCOSITY | S5 |
|---|------------|---------------------|-------------------|---------------------|-----|
| Z P | 84.4 | 80.6 | 0.88 | 542 | 8.8 |
| A Z P | 85.8 | 81.9 | 0.82 | 537 | 8.6 |
| Q Z P | 85.2 | 81.6 | 0.79 | 525 | 8.6 |
| X Z P | 86.7 | 83.2 | 0.68 | 511 | 8.7 |
| X Q Z P | 86.9 | 83.3 | 0.69 | 504 | 8.2 |
| Q Z ₁ E ₀ Z ₂ | 83.8 | 77.2 | 1.80 | 505 | 8.6 |
| Q Z ₁ E ₀ Z ₂ SO ₂ | 84.1 | 77.4 | 1.80 | 525 | 8.4 |
| Q Z ₁ (E ₀ P') Z ₂ | 84.8 | 78.8 | 1.50 | 411 | 8.6 |
| Q Z ₁ (E ₀ P') Z ₂ SO ₂ | 85.7 | 79.7 | 1.40 | 414 | 8.6 |
| Q Z ₁ P Z ₂ | 87.4 | 81.1 | 1.30 | 427 | 8.7 |
| Q Z ₁ P Z ₂ SO ₂ | 87.6 | 81.6 | 1.20 | 435 | 8.5 |

BLEACHING RESULTS: EMCC PULP + STANDARD O2

| SEQUENCE | BRIGHTNESS | REVERTED BRIGHTNESS | POST COLOR NUMBER | INTRINSIC VISCOSITY | S5 |
|---------------------|------------|------------------------|-------------------------|------------------------|-----|
| Z P | 83.7 | 80.6 | 0.75 | 579 | 8.3 |
| A Z P | 83.5 | 80.3 | 0.79 | 535 | 8.5 |
| Q Z P | 84.4 | 81.0 | 0.79 | 559 | 8.3 |
| X Z P | 84.0 | 80.8 | 0.76 | 512 | 8.2 |
| X Q Z P | 86.2 | 83.0 | 0.64 | 598 | 8.0 |
| Q Z1 E0 Z2 | 84.3 | 76.9 | 2.00 | 513 | 8.3 |
| Q Z1 E0 Z2 SO2 | 84.2 | 78.4 | 1.50 | 527 | 8.3 |
| Q Z1 (E0 P') Z2 | 86.5 | 78.8 | 1.80 | 413 | 8.3 |
| Q Z1 (E0 P') Z2 SO2 | 86.1 | 79.9 | 1.40 | 411 | 8.5 |
| Q Z1 P Z2 | 88.1 | 79.3 | 1.90 | 504 | 8.3 |
| Q Z1 P Z2 SO2 | 88.4 | 82.5 | 1.10 | 502 | 8.1 |

BLEACHING RESULTS: EMCC PULP + DRASTIC O₂

| <i>SEQUENCE</i> | <i>BRIGHTNESS</i> | <i>REVERTED BRIGHTNESS</i> | <i>POST COLOR NUMBER</i> | <i>INTRINSIC VISCOSITY</i> | <i>S5</i> |
|---|-------------------|--------------------------------|----------------------------------|--------------------------------|------------|
| <i>Z P</i> | <i>86.4</i> | <i>82.9</i> | <i>0.69</i> | <i>565</i> | <i>8.7</i> |
| <i>A Z P</i> | <i>86.1</i> | <i>82.3</i> | <i>0.78</i> | <i>579</i> | <i>8.7</i> |
| <i>Q Z P</i> | <i>88.6</i> | <i>85.0</i> | <i>0.59</i> | <i>562</i> | <i>8.5</i> |
| <i>X Z P</i> | <i>88.3</i> | <i>84.7</i> | <i>0.61</i> | <i>581</i> | <i>8.2</i> |
| <i>X Q Z P</i> | <i>88.9</i> | <i>85.5</i> | <i>0.54</i> | <i>524</i> | <i>8.0</i> |
| <i>Q Z₁ E₀ Z₂</i> | <i>85.0</i> | <i>79.6</i> | <i>1.30</i> | <i>554</i> | <i>7.9</i> |
| <i>Q Z₁ E₀ Z₂ SO₂</i> | <i>85.3</i> | <i>79.8</i> | <i>1.30</i> | <i>579</i> | <i>7.9</i> |
| <i>Q Z₁ (E₀ P^ˆ) Z₂</i> | <i>88.2</i> | <i>81.5</i> | <i>1.30</i> | <i>492</i> | <i>8.1</i> |
| <i>Q Z₁ (E₀ P^ˆ) Z₂ SO₂</i> | <i>88.6</i> | <i>82.2</i> | <i>1.20</i> | <i>488</i> | <i>8.1</i> |
| <i>Q Z₁ P Z₂</i> | <i>88.6</i> | <i>83.0</i> | <i>1.00</i> | <i>534</i> | <i>7.9</i> |
| <i>Q Z₁ P Z₂ SO₂</i> | <i>89.3</i> | <i>83.9</i> | <i>0.90</i> | <i>543</i> | <i>8.0</i> |

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3-Ozone Bleaching

Dr. Rudra P. Singh, president & CEO, Emerging Technology Transfer, Inc, USA

4-Low AOX Bleaching

Hassan L. Loutfi, corporate technical manager, Irving Pulp & Paper Mills, Ltd., Canada

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William Miller, manager, process technology, Ingersoll-Rand Co., Nashua, N.H.

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Please Note: Submission of a paper was not a requirement of session panelists. If a paper was submitted, it is included in section 21.

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Brazil - Dr. Celso Foelkel, director of technology and environment, Riocell SA

Canada - Hasan Loutfi, corporate technical manager, Irving Pulp & Paper Ltd.

India - Shailendra K. Jain, senior executive president, Grasim Industries Ltd.

Sweden - Dr. Jiri Basta, head of bleaching chemicals, research and development, Eka Nobel AB

USA - Walter Kleinberg, manager, pulp and paper processes, Airco Gasses; Dr. Malcolm Beaverstock, director, advanced technology, Automation Technology; Troy Wilks, Weyerhaeuser Co., Newborn Mill

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Drs. Paul F. Earl, project scientist, and Xuan T. Nyuyen, Domtar Inc., Canada

33—Softwood and Hardwood Market Kraft Pulps

Dr. Lars-Ake Lindström, group vice president, and Gunnar Carré, Sunds Defibrator AB, Sweden

34—Advantage in High Consistency Bleaching Technology with Peroxide and Ozone

Dr. J. Kappel, M. Grengg and P. Bräuer, Andritz AG, Austria

SESSION VIII PAPERS: NEW DEVELOPMENTS IN NON-CHLORINE BLEACHING

35—Peracetic Acid as a Selective Pre-Bleaching Agent: An Effective Option for the Production of TCF Kraft Pulps

Francois Desprez, research and development, Dr. J. Devenyns, and N. Troughton, Solvay-Interox Co., Belgium

36-Modern ECF and TCF Bleached Pulps

Dr. Brita Swan, technical director, Johannes Flink, and Roland Grundelius, Stora Teknik AB, Sweden

37-Isothermal Cooking to Low Kappa Numbers Facilitates TCF Bleaching to Full Brightness

Bjorn Dillner, manager of process development dept., and Petter Tibbling, Kamyr AB, Sweden

38-Alternative Pathways in Non-Chlorine Bleaching

Drs. Rajai Atalla, I.A. Weinstock, E.I. Springer, and J.L. Minor, USDA Forest Service, Forest Products Laboratory

39-Peroxide and Ozone Combination Bleaching

Dr. Peter Axegard, research director of pulp dept, STFI, Sweden

40-The Use of Enzymes to Enhance Pulp Bleaching

Dr. Jeffrey S. Tolan, senior research scientist, Iogen Corp., Canada

41-Fundamental Studies of Dimethyldioxirane as a Bleaching Reagent for Kraft Pulps

Dr. A.J. Ragauskas, Institute of Paper Science and Technology

SESSION IX PAPERS: CLOSED CYCLE MILL

42-Technical and Economic Feasibility of the Effluent-Free Bleached Kraft Pulp Mill

Richard J. Albert, technical staff manager, Parsons Main, Inc.

43-Impact of Ozone Bleaching-Impact of Ozone and Total Chlorine-Free Bleaching on Mill Sodium/Sulfur Balance

L.D. Shackford, and S. Minami, Ingersoll-Rand, IMPCO Div.

44-A Survey of Research and Development Activity in Bleached Kraft Mill Closed-Cycle

Peter Gleadow and Calvin Hastings, H.A. Simons Ltd., Canada; Tony Johnson, Simons Eastern Consultants; Björn Wamqvist, AF-IPK AB, Sweden

SESSION X PAPERS: PANEL ON IMPLEMENTATION OF EMERGING TECHNOLOGIES WORLDWIDE

Please Note: Submission of a paper was not a requirement of session panelists. If a paper was submitted, it is included in section 45.

45-

Brazil - Dr. Celso Foelkel, director of technology and environment, Riocell SA

Austria - Dr. Walter Peter, production manager, Lenzing AG

Finland - Ismo Reilama, project coordinator, Oy Metsa-BotniaAB

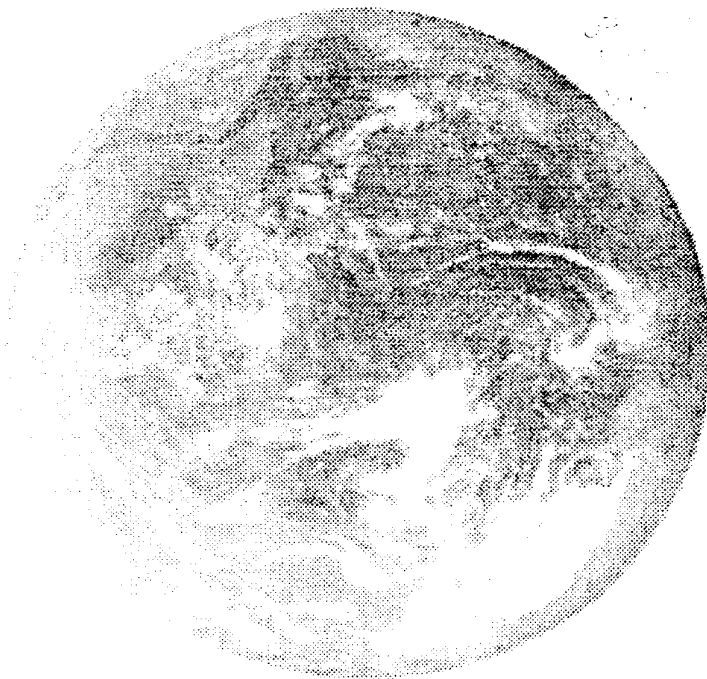
Sweden - Dr. Peter Axegard, research director of pulp dept., STFI, Stockholm

Norway - Dr. Peder Kleppe, vice president of technology, M. Peterson and Son AS

USA - Dr. Thomas McDonough, professor, IPST

USA - Dr. I.J. Wilk, Brincell, Inc.

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