# BLEACHING PROCESSES FOR THE PRODUCTION OF MECHANICAL AND CHEMI-MECHANICAL PULPS OF HIGH BRIGHTNESS

## Double-stage bleaching is most cost-effective

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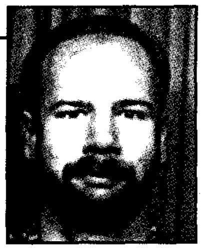

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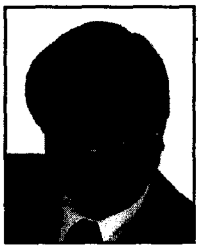

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SHEET BRIGHTNESS is one of the most important quality criteria of printing and writing paper grades on the market. In addition to surface finish, the sheet must be free of dirt and it must be bright with the right bluish shade. The sales price of printing and writing paper grades is directly related to the sheet brightness, Fig. 1. With the exception of telephone directory, all other paper grades fall within a narrow band when the sales price is plotted as a function of ISO-brightness.

The sheet characteristics required on the market for printing and writing grades are achieved by the papermaker by adjusting paper machine and calendering/coating conditions as well as by changing the furnish composition, that is, the ratio of mechanical to chemical fibre content, fillers, additives, and so on. It is well known to papermakers that the mechanical or chemi-mechanical pulp content decreases when higher quality printing and writing grades are produced. The current levels in each of the grades may vary appreciably.

Figure 1 illustrates the average percentage of mechanical fibres in the furnish. To increase the content of these pulps in the high value added grades, the mechanical pulps must have the right combination of fibre morphological characteristics. In addition to these,

**TABLE I: COMMERCIAL BLEACHING PROCESSES.**

| Chemical/Process | Maximum Brightness Gain (Spruce/Balsam) | References |
|---|---|---|
| **Sodium sulphite ($Na_2SO_3$)** | | |
| • Chips | 6 points | 22 |
| • Interstage | 4 points | 22 |
| • Refiner | 2-3 points | 23 |
| • Latency Chest | 2-3 points | 23 |
| **Hydrosulphite ($Na_2S_2O_4$)** | | |
| • Low consistency 3-4% | 6-7 points | 7, 24 |
| • Medium consistency 10-12% | 7-9 points | 8 |
| • Refiner | 10-11 points | 7 |
| **Peroxide ($H_2O_2$)** | | |
| • Chips | 16-18 points | 25 |
| • Interstage | 16-18 points | 1 |
| • Rejects | 16-18 points | 26, 27 |
| • Post refining | | |
| • Single stage MC or HC | 16-18 points | 15, 20, 30, 32 |
| • Two stage MC - MC | 16-18 points | 15-20, 31 |
| • Two stage MC - HC | 16-18 points | 15-20, 31 |
| **Oxidation-reduction ($H_2O_2$ – $Na_2S_2O_4$ or $NaBH_4$)** | | |
| • PY, BP | 18-20 points | 2-4, 24, 29 |
| • PBP, PYP | 18-20 points | 2,4,5 |
| • BPP, YPP | 18-20 points | 2,4,6 |

**TABLE II: VARIABLES AFFECTING CHEMICAL COSTS IN SINGLE- AND DOUBLE-STAGE PEROXIDE BLEACHING OF MECHANICAL AND CHEMI-MECHANICAL PULPS.**

(1) Wood species
(2) Wood age/dead/decayed wood
(3) Bark content
(4) Metal profile content
(5) Quality of fresh water and paper machine disc filter white water
(6) Preheater temperature (TMP)
(7) Pulp sulphonation levels (CTMP, CMP)
(8) Washing efficiency of interstage washing presses
(9) White water recirculation strategy in the pulping plant
(10) Fresh water consumption in the mill
(11) Washing efficiency of presses in the bleach plant
(12) Peroxide charge on pulp
(13) Alkalinity of buffer solution
(14) Pulp consistency: in tower in single stage bleaching
(15) Pulp consistency: in P1 and P2 towers in double stage bleaching
(16) Recirculation strategy of the residual peroxide
(17) Mixing efficiency
(18) Reaction time and temperature
(19) Pulp neutralization after bleaching

**TABLE III: CHEMICAL PRE-TREATMENT AND REFINING CONDITIONS OF THE CTMP PLANT.**

| Wood species | Spruce/balsam |
|---|---|
| DCM extractives in wood (%) | 1.8 |
| Reaction bin | |
| Temperature (°C) | 95 |
| Retention time (min.) | 30 |
| Preheater | |
| Temperature (°C) | 115 |
| Retention time (min.) | 3 |
| Impregnation chemicals $Na_2SO_3$(%) | 3 |
| DTPA (%) | 0.4 |
| Specific energy at 150 mL CSF (MWh/odmt) | 2.35 |
| Pulp production (odmt/day) | 485 |

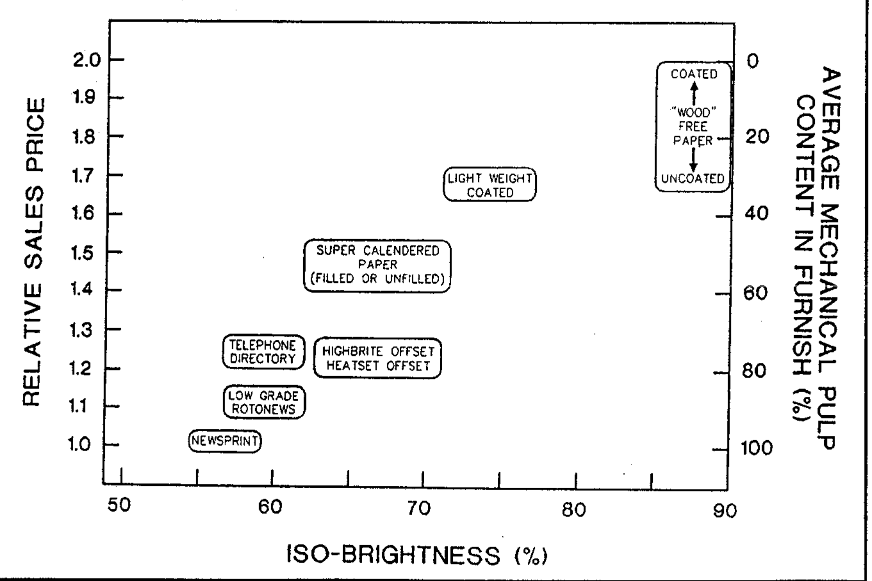


FIG. 1. RELATIVE SALES PRICE OF NEWSPRINT AND SPECIALTY GRADES AS A FUNCTION OF ISO BRIGHTNESS. THE PRICE INCREASES WITH HIGHER BRIGHTNESS WHILE THE AVERAGE MECHANICAL PULP CONTENT IN THE FURNISH DECREASES.

an important criterion is evidently the brightness and shade of these pulps.

It is currently recognized by all that a breakthrough in bleaching technology is needed to surpass the current plateau level of 80 to 82% ISO-brightness that exists when bleaching spruce/balsam CTMP mixtures. Aspen BCTMP pulps, however, can be produced at a brightness level of 85 to 86% ISO. This explains the current success of these pulps in printing and writing paper grades [1].

Several bleaching processes or brightening practices have been proposed or are currently used to improve mechanical pulps brightness. These are listed in Table I with some typically achievable brightness gains.

Three bleaching chemicals are currently commonly used: sodium sulphite ($Na_2SO_3$), sodium hydrosulphite ($Na_2S_2O_4$, subsequently designated as Y in this study) and hydrogen peroxide ($H_2O_2$, subsequently designated as P in this study). Another bleaching chemical has also been proposed [2-6] in multistage bleaching sequences: sodium borohydride ($NaBH_4$, subsequently designated as B in this study). The use of this bleaching chemical, however, has not received commercial acceptance.

Several brightening practices, such as the addition of sulphite on chips in the refiner or in the latency chest, have been used for many years to solve brightness problems associated with the mills' use of old wood in the winter and the spring. Brightness gains of 2 to 6 points can be achieved.

The use of hydrosulphite in upflow bleaching towers at low consistency, in pipes, in chests or as in recently proposed disc refiners [7] or at medium consistency [8] offers several benefits. These practices do not allow for the bleaching of mechanical and chemi-mechanical pulps to high brightness values, which are desirable for their use in printing and writing grades (80 to 85%+ ISO).

Peroxide, however, is currently the most favored bleaching chemical as it allows pulp to be bleached to high brightness levels. Numerous studies and commercial practices confirm that brightness values of 80 to 82% ISO can be reached with spruce/balsam CTMP pulps and values of 86 to 87% ISO can be reached with aspen CTMP, CRMP-i and APP using peroxide in one or two stages, interstage or on chips [1,15,20,25]

In previous studies [24] we have reported results on multi-stage bleaching sequences involving peroxide as an oxidizing agent and another bleaching chemical as a reducing agent. It was shown that several sequences can also produce high-brightness pulps. It was concluded, on the basis of the total peroxide consumed in these different process alternatives, that the sequence in two-stage peroxide followed by hydrosulphite (PY) and the

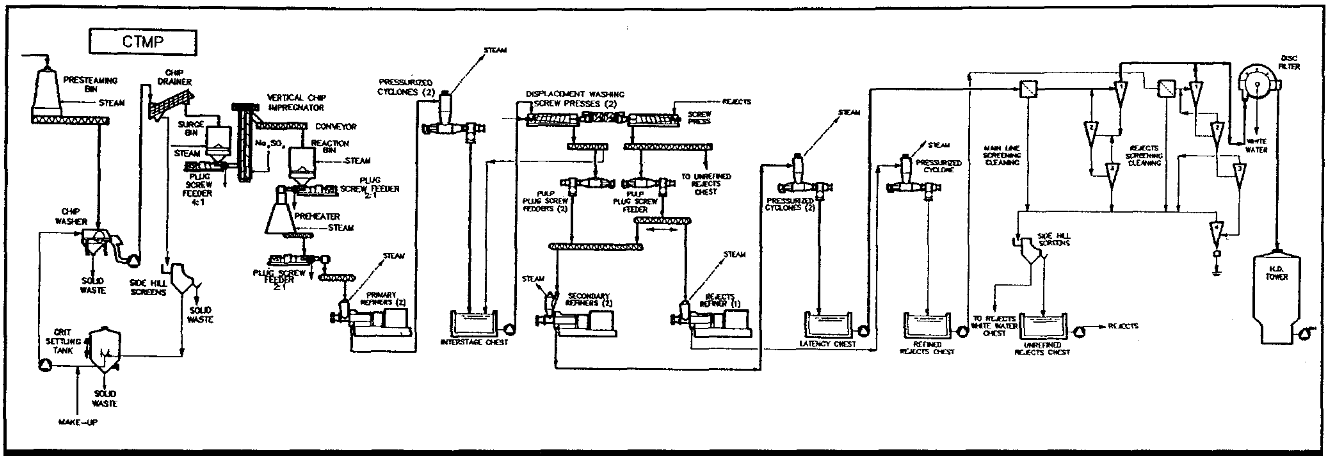


FIG. 2. THE PROCESS FLOW DIAGRAM OF THE CTMP PULPING PLANT WITH INTERSTAGE WASHING USED IN THE GEMS SIMULATION.

sequence in three-stage hydrosulphite-peroxide-peroxide (YPP) were the most effective sequences in terms of the maximum brightness levels achieved, pulp yellowness and bleaching costs.

Another study [3] showed that CTMP pulps responded in different ways — after bleaching with different chemicals under different sequences — to commercial dyes which are normally added in the paper making process to achieve the right yellow shades in the final sheet. It was concluded that the two-stage bleaching sequence of peroxide followed by hydrosulphite, was the most cost effective sequence after dye addition

This paper compares several bleaching sequences which are currently used to produce high-brightness pulps. Processes which may be used in integrated mills, such as single-stage peroxide bleaching (P) at high consistency (HC) and at medium consistency (MC), with and without recycling of the residual peroxide, are compared with the double-stage bleaching sequence of peroxide followed by hydrosulphite (PY).

Subsequently, we compare bleaching processes which can be used in market pulp mills such as double-stage peroxide bleaching (PP) at medium consistency in each bleaching stage (MC-MC) and at medium consistency in the first stage and at high consistency in the second stage (MC-HC). Both processes are subsequently compared with the sequence of peroxide followed by hydrosulphite (PY).

To evaluate the fresh peroxide requirement and bleaching cost, we have done detailed mass balance calculations of all the bleach plants using the GEMS simulation package for which laboratory bleaching results obtained for a commercial CTMP spruce/balsam mixture were used as the input data. The processes are compared in terms of ISO-brightness obtained at a given chemical charge or bleaching costs, the maximum ISO-brightness values obtained, the yellow shade of the pulps and their luminosity. ISO-brightness results after thermal reversion are also presented.

## RESULTS

Several variables affect chemical consumption in single- and double-stage peroxide bleach plants. These may be related to the nature of the raw materials and their special characteristics, the refiner pulping plant operating conditions, concept and selection of equipment, the specific chemistry of the bleaching chemicals used and the operating conditions, selected equipment and concept of the bleach plant. Table II lists these variables.

In this study we have used a commercial spruce/balsam CTMP to establish the bleaching response in terms of the intrinsic wood characteristics. The high initial pulp brightness is attributed by the mill to efficient woodland procedures, high water use and extremely high pulp cleanliness in terms of dirt count

To take into consideration the variables involved with the refiner pulping plant's operating conditions and other specific conditions in the mill, in conjunction with the bleach plant's specific bleaching conditions and white water recirculation strategies, we have taken an approach that consists of simulating an entire CTMP plant and bleach plant using the GEMS computer simulation package.

In previous articles this approach was used to compare different process alternatives with pines [5,9,10,11]. Figure 2

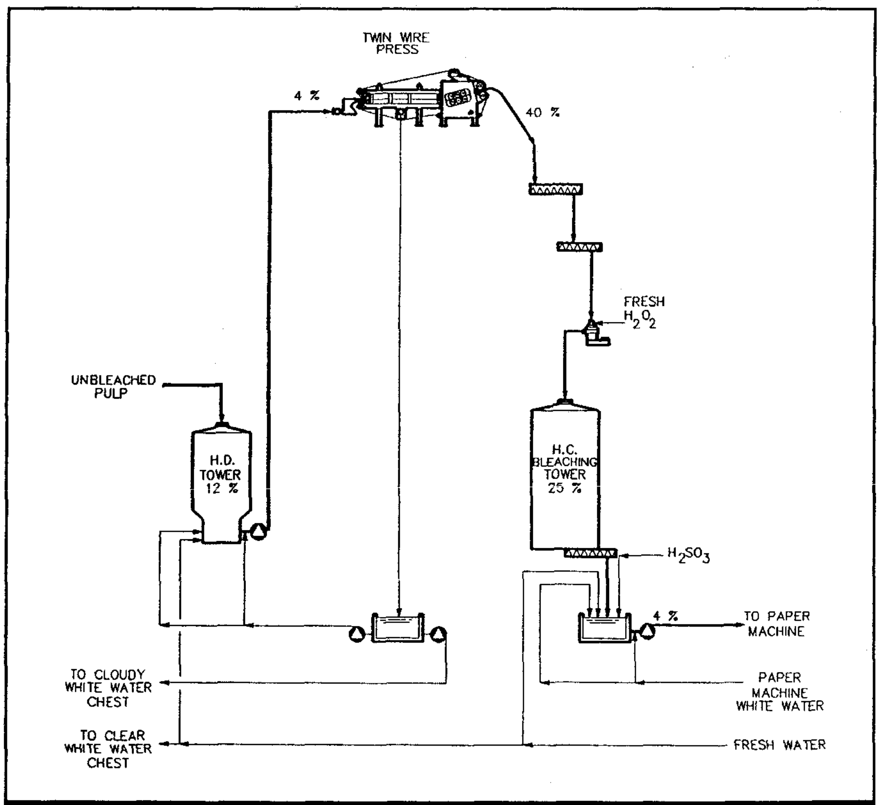


FIG. 3. THE PROCESS FLOW DIAGRAM OF A HIGH-CONSISTENCY, SINGLE-STAGE PEROXIDE BLEACH PLANT.

illustrates the process flow diagram of the CTMP plant with interstage washing that was used in the present study. The chemical pretreatment and refining conditions are given in Table III. In this process the fresh water is added in the bleach plant at the end of the process and countercurrent washing is used. The sewer points are at the fourth-stage cleaner of the reject treatment plant, at the interstage washing presses and at the chip washing system.

The bleach plants evaluated in the present study are represented in Figs. 3 to 9. Each of these plants was added to the refiner plant of Fig. 2. Laboratory results of ISO-brightness as a function of peroxide added and consumed, as well as hydrosulphite charge, were used as the input data in the mass balance calculations. The effects of sodium sulphite and dissolved organic solids were taken into consideration. The relationship between peroxide and dissolved organics present in the white water was taken from another study [28], in which the following empirical equation was derived:

$$\% \text{ peroxide} = 0.0092 \bullet \text{COD (kg/odmt)} \bullet \text{ISO-brightness gain}(\%)$$

The stoichiometric equation of the oxidation of sodium sulphite into sodium sulphate, in the presence of peroxide, was used to take into account the effect of the sodium sulphite carry over from the refiner pulping plant:

$$Na_2SO_3 + H_2O_2 \rightarrow Na_2SO_4 + H_2O$$

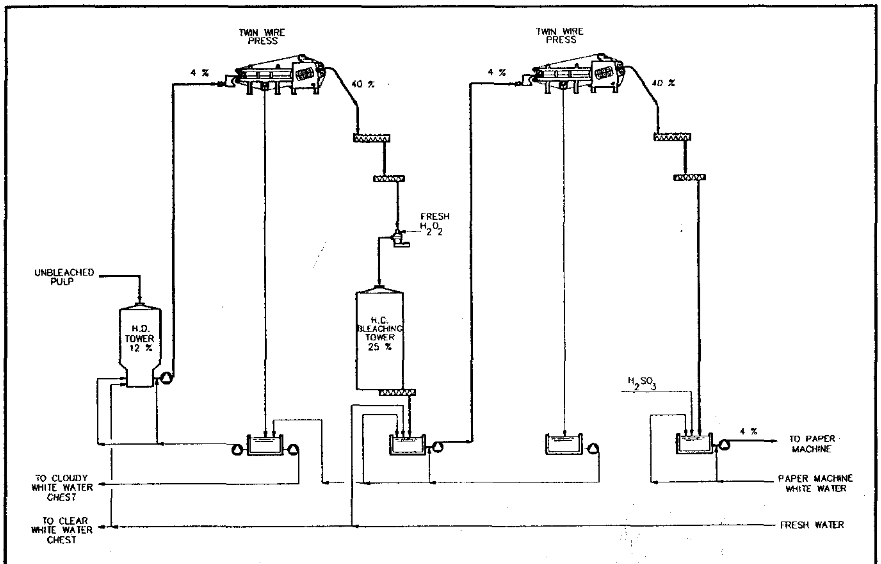


FIG. 4. THE PROCESS FLOW DIAGRAM OF A HIGH-CONSISTENCY, SINGLE-STAGE PEROXIDE BLEACH PLANT WITH POST-WASHING.

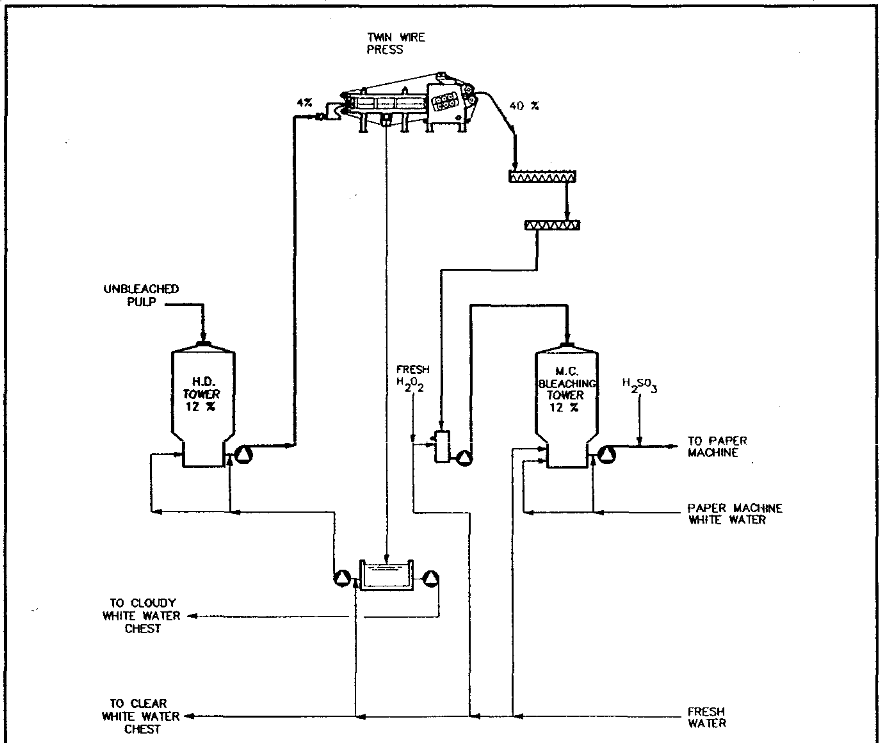


FIG. 5. THE PROCESS FLOW DIAGRAM OF A MEDIUM-CONSISTENCY, SINGLE-STAGE PEROXIDE BLEACH PLANT.

**Comparison of bleaching processes for integrated mills:** Several peroxide bleaching processes can be used for bleaching mechanical and chemimechanical pulps in integrated mills. Single-stage peroxide bleach plants, operating at either high consistency (25 to 30%) or at medium consistency (12 to 18%), constitute two main options. The experimental results of Fig. 10 clearly show the advantage of bleaching at high consistency over medium consistency. Less peroxide is required, particularly at high brightness values. This leads to an appreciably lower bleaching cost to reach a given brightness level.

For a given bleaching cost, the pulp yellowness is appreciably lower for the pulps bleached at high consistency. The luminosity of the pulps is also higher at any given b• value. High-consistency bleaching can also lead to the highest maximum ISO-brightness values.

Figure 10 shows major savings in peroxide cost for those mills currently bleaching in the medium-consistency range if the bleaching consistency of the plant were increased with the addition of the proper dewatering device with a high-consistency shear mixer.

Another option that we have been asked to comment upon, several times, is the merit of adding a recovery press at the outlet of the medium-consistency tower and reusing the residual peroxide in the same tower. A higher residual is always obtained with medium-consistency bleaching. This process is illustrated in Fig. 6. Results from Fig. 10 demonstrate that this option does not constitute a cost-effective solution to reducing the overall bleaching cost. Savings are not substantial. Although some peroxide is recovered, there is a limit to the amount that can be reintroduced in the tower. Furthermore, this peroxide liquor solution also contains appreciable amounts of dissolved solids which impair the bleaching efficiency of the fibres.

For the production of certain specialty paper grades of high brightness such as SC/LWC, it may be preferable to bleach the mechanical or chemimechanical pulp at high consistency and use a washing stage after bleaching, Fig. 4. The press after the bleach plant allows for washing out the silicate and other dissolved solids from the pulp before sending it to the paper machine. The benefits of this approach were discussed previously in papers on pine bleaching [9,12]. The main objective is to remove materials which are known to alter sheet quality and upset paper machine runnability [13]. We estimated in our study that there are approximately 45% lower total dissolved solids at the paper machine when a washing stage is added after bleaching and when the pulp is washed with 30 $m^3$/odt of clean fresh water. These results will be presented in a future study[14].

As a result of our previous work [3,4], we have found it interesting to investigate the bleaching sequence of peroxide followed by hydrosulphite (PY), Fig. 7. Experimental results were obtained for different peroxide charges and for charges of 0.5, 1.0 and 1.5% hydrosulphite.

In Fig. 11, results are compared for the PY bleaching sequence with the single-stage peroxide (P) bleaching sequences at high and medium consistency. Results for the PY sequence using 1.0% hydrosulphite charge have been plotted on this figure. It can be seen that brightness values systematically 1 to 3 points higher are obtained with the PY bleaching sequence at a given peroxide charge or bleaching cost. The PY bleaching sequence is, therefore, the most cost-effective bleaching sequence. At a given bleaching cost the bleached pulps from the PY sequence are less yellow. The luminosity, as a function of b•, is also the highest for the PY bleaching sequence. It may be concluded, therefore, that this bleach plant may constitute an interesting option for those mills already bleaching with hydrosulphite and where the cost of hydrosulphite is lower than that of peroxide

**Comparison of bleaching processes for market pulp mills:** It is usual practice for market pulp mills to use peroxide as a bleaching chemical in two successive stages. Either bleaching tower can operate at medium consistency (MC-MC) as shown in Fig. 8, or the first tower can operate at medium consistency and the second one at high consistency (MC-HC) as shown in Fig. 9. In our study, we have used laboratory results as input data to compare both of these processes. The time and temperature used in each stage were set according to commercial practice. An optimum alkalinity defined as NaOH + 0.11 $Na_2SiO_3$ (w/wfibre) of 1.2 to 1.0 in $H_2O_2$ (W/W) was applied in each bleaching stage in accordance with current practice [15-19]. The split in the total peroxide charge between the first and second stages was set as 1/5 and 4/5. This split is based on average values obtained in the operation of a two-stage peroxide bleach plant when all the fresh peroxide is added in the second stage and the residual peroxide from the second tower is recirculated to the first tower. This corresponds to the lowest total charge and bleaching cost.

Figure 12 compares results for the double-stage peroxide bleaching processes (MC-MC) and (MC-HC) with the peroxide-hydrosulphite bleaching process (PY). It is seen that the double-stage bleaching sequence (MC-HC) is more cost-effective than the (MC-MC) sequence. This finding agrees with a previous study using a GEMS computer simulation [20]. However, this study had only demonstrated a slight superiority of the (MC-HC) bleaching sequence over the (MC-MC) sequence.

Greater differences exist between both processes when the contribution of sulphite and dissolved solids on peroxide consumption are taken into consideration. Furthermore, in our experience, the use of medium consistency in the first stage allows the recovery of more residual peroxide from the last stage of bleaching

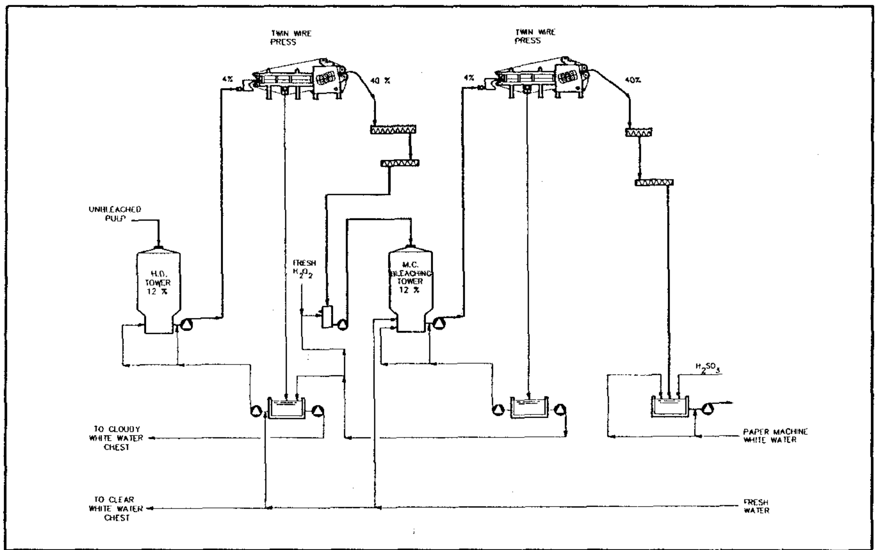


FIG. 6. THE PROCESS FLOW DIAGRAM OF A MEDIUM-CONSISTENCY, SINGLE-STAGE PEROXIDE BLEACH PLANT WITH POST WASHING AND RECOVERY OF THE RESIDUAL PEROXIDE.

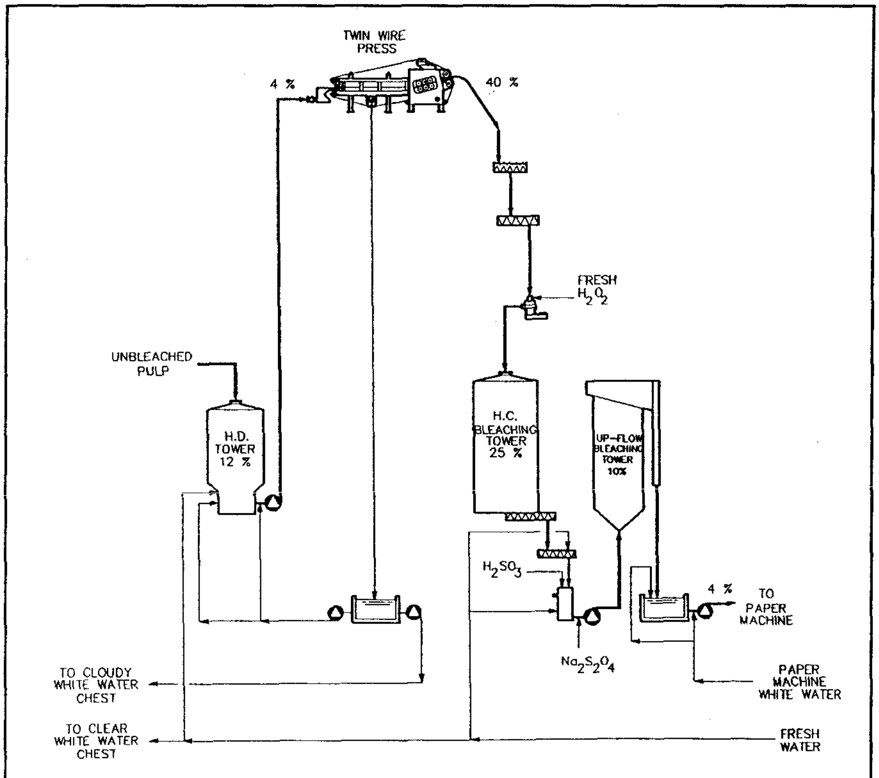


FIG. 7. THE PROCESS FLOW DIAGRAM OF THE PEROXIDE-HYDROSULPHITE BLEACH PLANT. THE PEROXIDE BLEACHING IS DONE AT HIGH CONSISTENCY AND THE HYDROSULPHITE BLEACHING IS DONE AT MEDIUM CONSISTENCY.

and, therefore, allows bleaching at high brightness values at lower cost.

One question of interest to many is whether or not a double-stage peroxide bleach plant is required to reach high brightness levels or to effectively obtain lower bleaching costs. The question always arises when it is realized that the equipment required represents a high capital cost investment. It can be seen from Fig. 13 that the maximum brightness achieved with a single-stage peroxide bleach plant at high consistency is comparable to that achieved with a two-stage bleach plant (MC-HC). However, the bleaching cost to reach a given ISO-brightness value of a double-stage peroxide bleach plant (MC-HC) is appreciably less than for single-stage bleaching, particularly at high brightness levels.

Due to the high brightness gains of the PY bleaching sequence, we have found it interesting to compare those results with those of the best single-stage (HC) and the best double-stage peroxide bleach plants (MC-HC). It can be seen from Figs. 12 and 13 that higher maximum brightness gains are achieved with the PY sequence and it is also more cost effective. Furthermore, the bleached pulps are appreciably less yellow compared with those from double-stage peroxide sequences.

Figure 14 compares the brightness loss after thermal reversion. It can be seen that the brightness reversion of all the pulps bleached with peroxide fall on a common line as a function of the ISO-brightness of the pulps before reversion. An appreciable brightness loss is observed at high brightness levels. The pulps bleached following the PY sequence exhibit far less brightness reversion. In Fig. 14, we have plotted the results obtained for pulps bleached with the PY sequence in which different peroxide and hydrosulphite charges of 0.5, 1.0 and 1.5% were used. The pulps bleached following the PY sequence exhibit less brightness reversion. It would appear that the hydrosulphite bleaching stage stabilizes the pulp brightness for peroxide addition above 4%.

## CONCLUSIONS

The following conclusions can be drawn from this work:

- Single-stage peroxide bleaching at high consistency is a more cost-effective process than peroxide bleaching at low consistency.
- Minor benefits in bleaching cost are obtained with the recovery of the residual peroxide with a press at the outlet of a medium-consistency bleaching plant compared to high-consistency bleaching. It is evident that far greater benefits are obtained by modifying the plant to bleach at high consistency.
- A double-stage peroxide bleach plant at medium consistency followed by high consistency (MC-HC) is a more cost-effective bleaching process than a double-stage peroxide bleach plant with both stages at medium consistency (MC-MC).
- Comparable maximum brightness is achieved in single-stage peroxide bleaching at high consistency compared to double-stage peroxide bleaching at medium consistency in the first stage and high consistency in the second (MC-HC).
- The bleaching cost to reach a given ISO-brightness value of a double-stage peroxide bleach plant (MC-HC) is lower than for single-stage bleaching, particularly at high brightness levels.
- The bleaching sequence of peroxide

**TABLE IV: ESTIMATED CHEMICAL UNIT COST.**

| | CD$/kg* |
|---|---|
| Hydrogen peroxide (100%) | 1.27 |
| Sodium silicate (41°Be) | 0.22 |
| Sodium hydroxide (100%) | 0.41 |
| DTPA (40%) | 1.20 |
| Magnesium sulphate (100%) | 0.38 |
| Sulphur dioxide (100%) | 0.30 |
| Sodium hydrosulphite (100%) | 2.02 |

(*) 1 US$ = 1.2 CD$
Source: (33, 34, 35 and supplier's literature)

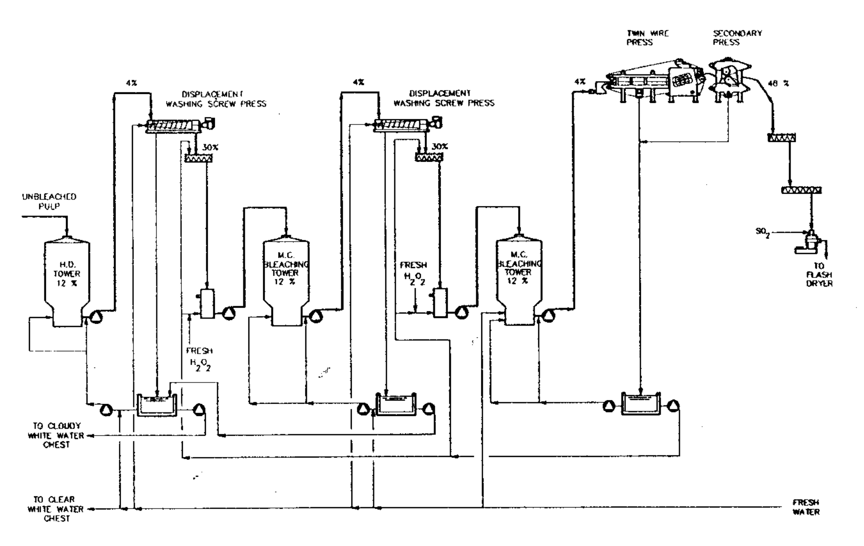


FIG. 8. THE PROCESS FLOW DIAGRAM OF A DOUBLE-STAGE PEROXIDE BLEACH PLANT (MC-MC) WITH RECIRCULATION OF THE RESIDUAL PEROXIDE AND COUNTERCURRENT WASHING.

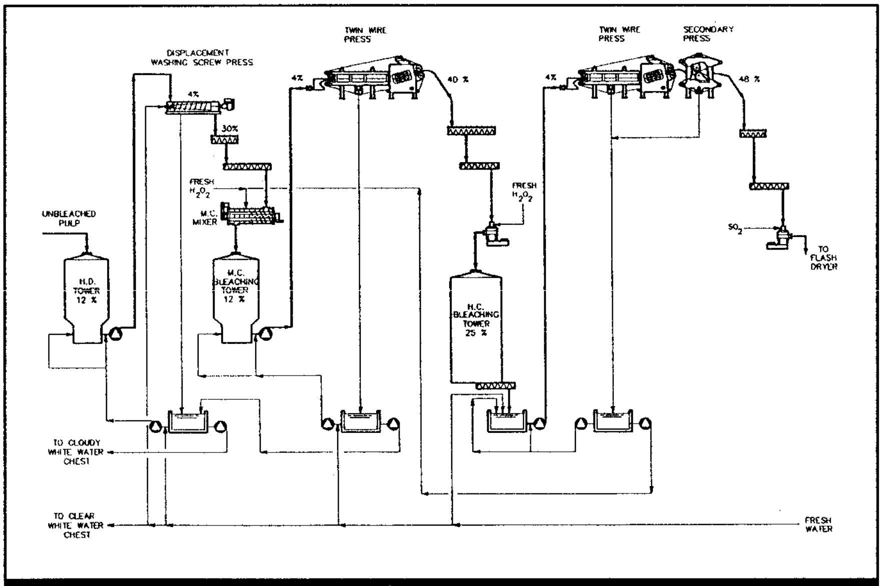


FIG. 9. THE PROCESS FLOW DIAGRAM OF A DOUBLE-STAGE PEROXIDE BLEACH PLANT (MC-HC) WITH RECIRCULATION OF THE RESIDUAL PEROXIDE AND COUNTERCURRENT WASHING.

followed by hydrosulphite (PY) allowed for achieving the highest maximum ISO-brightness. This sequence is also the most cost-effective bleaching sequence studied. It produces pulp of high luminosity and lowest yellow stage.

• The pulps bleached following the PY sequence exhibit less brightness reversion after thermal treatment compared to pulps bleached in one or two stages with peroxide only, particularly at high peroxide charges.

## EXPERIMENTAL

A chemi-thermomechanical spruce/balsam pulp from an eastern Canadian newsprint and specialty grade mill was used in this work. The pulp was exceptionally clean and free of bark. The initial brightness of the pulp was 68% ISO. The brightness reported was measured with an Elrepho spectrophotometer. Measurements made with Filter nos. 8, 9, 10 and 11 were used to calculate the parameters of the CIE LAB reference system. A detailed description of the experimental procedures followed for pulp washing and pretreatment, bleaching, interstage treatment, residual peroxide

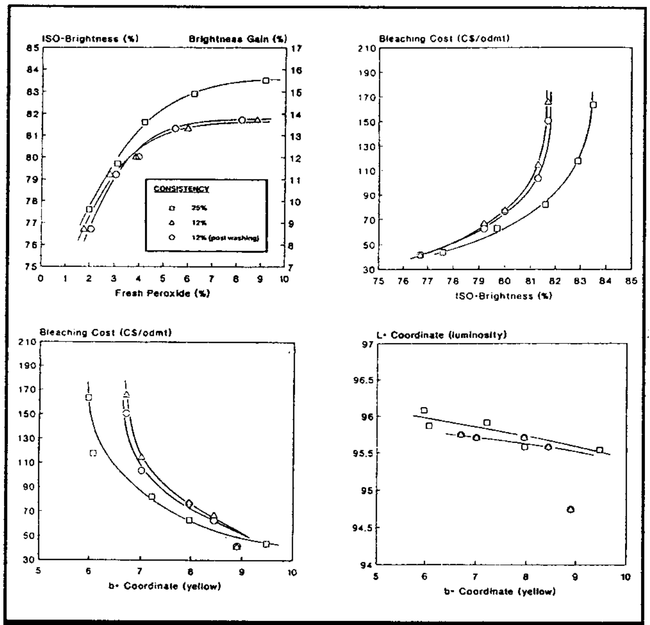


FIG. 10. COMPARISON OF ISO BRIGHTNESS, ESTIMATED BLEACHING COST, PULP YELLOWNESS AND LUMINOSITY OF THE SINGLE-STAGE PEROXIDE BLEACH PLANT AT HIGH CONSISTENCY (FIG. 3), AT MEDIUM CONSISTENCY (FIG. 5), AND AT MEDIUM CONSISTENCY WITH POST-WASHING AND RECOVERY OF THE RESIDUAL PEROXIDE (FIG. 6).

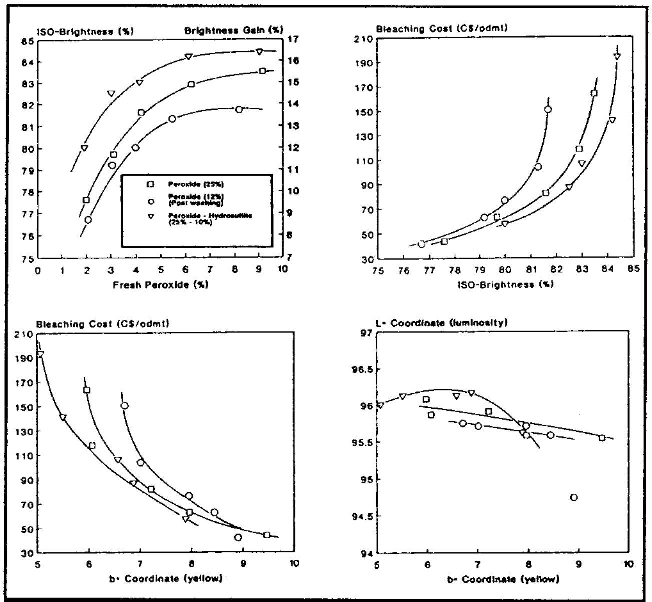


FIG. 11. COMPARISON OF ISO BRIGHTNESS, ESTIMATED BLEACHING COST, PULP YELLOWNESS AND LUMINOSITY OF THE SINGLE-STAGE PEROXIDE BLEACH PLANT AT HIGH CONSISTENCY (FIG. 3), AT MEDIUM CONSISTENCY WITH POST-WASHING AND RECOVERY OF THE RESIDUAL PEROXIDE (FIG. 6), AND THE DOUBLE-STAGE PEROXIDE-HYDROSULPHITE BLEACH PLANT (FIG. 7) WITH A 1% HYDROSULPHITE CHARGE.

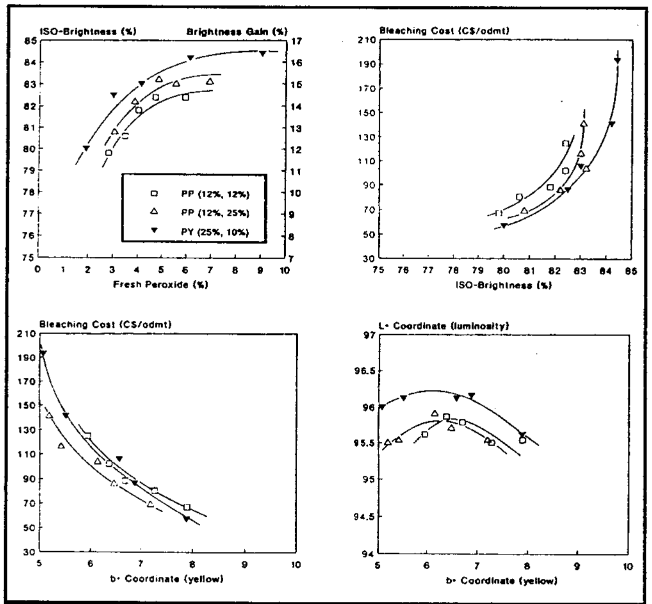


FIG. 12. COMPARISON OF ISO BRIGHTNESS, ESTIMATED BLEACHING COST, PULP YELLOWNESS AND LUMINOSITY OF THE DOUBLE-STAGE PEROXIDE BLEACH PLANTS USING PEROXIDE IN EACH STAGE (FIGS. 8 AND 9) AND THE PEROXIDE-HYDROSULPHITE BLEACHING SEQUENCE (FIG. 7) WITH A 1% HYDROSULPHITE CHARGE.

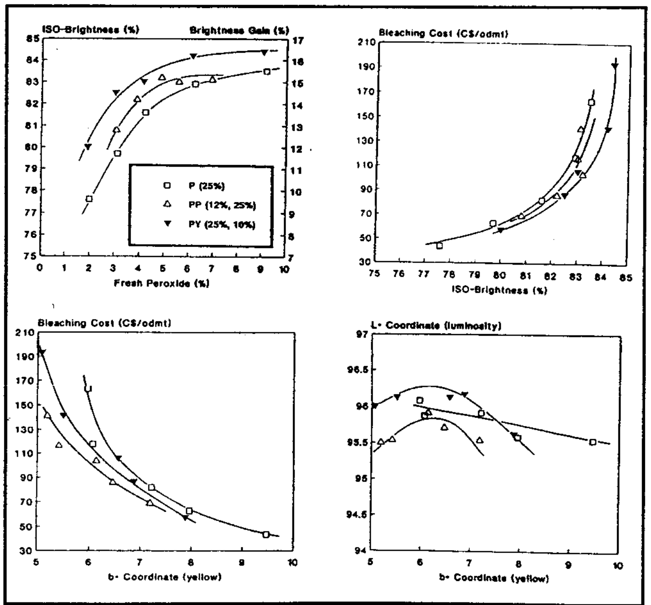


FIG. 13. COMPARISON OF ISO BRIGHTNESS, ESTIMATED BLEACHING COST, PULP YELLOWNESS AND LUMINOSITY OF THE PY BLEACHING SEQUENCE (FIG. 7) WITH A 1% HYDROSULPHITE CHARGE, WITH THE BEST SINGLE-STAGE PEROXIDE BLEACH PLANT (HC, FIG. 3) AND THE BEST DOUBLE-STAGE PEROXIDE BLEACH PLANT (MC, HC, FIG. 9).

measurement, sheet making and thermal reversion treatment conditions can be found elsewhere [21]. The chemical charges, bleaching temperature, time, consistency and total alkalinity are given in Table V.


## ACKNOWLEDGEMENTS

The authors thank Sophie Janknecht, Daniel Bergeron, Mavi Pizolitto and Francine Charron for their technical assistance in the experimentation and preparation of this manuscript. The financial assistance of Kvaerner Hymac in the form of a scholarship given to Stéphan Lafrenière is also gratefully acknowledged.


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TABLE V: EXPERIMENTAL BLEACHING CONDITIONS.

| | P | | PP | | | | PY | |
|---|---|---|---|---|---|---|---|---|
| | HC | MC | MC P1 | HC P2 | MC P1 | MC P2 | HC P1 | MC P2 |
| Consistency (%) | 25 | 12 | 12 | 25 | 12 | 12 | 25 | 10 |
| Temperature (°C) | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 60 |
| Reaction time (min) | 90 | 90 | 60 | 120 | 60 | 120 | 90 | 60 |
| DTPA (%) | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| pH | 10.5-12.0 | 10.5-12.0 | 10.3-11.3 | 11.4-11.9 | 10.3-11.2 | 11.4-12.0 | 10.5-12.0 | 5.5 |
| $Na_2SiO_3$(%) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | — |
| Epsom salt (%) | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | — |
| NaOH (%) | 0.86-9.26 | 0.86-9.26 | 0.38-1.58 | 2.54-7.34 | 0.38-1.58 | 2.54-7.34 | 0.86-0.26 | — |
| $H_2O_2$ (%) | 1,2,3 5&8 | 1,2,3 5&8 | 0.6-1.6 (1/5) | 2.4-6.4 (4/5) | 0.6-1.6 (1/5) | 2.4-6.4 (4/5) | 1,2,3 5&8 | — |
| $Na_2S_2O_4$(%) | — | — | — | — | — | — | — | 0.5,1,1.5 |

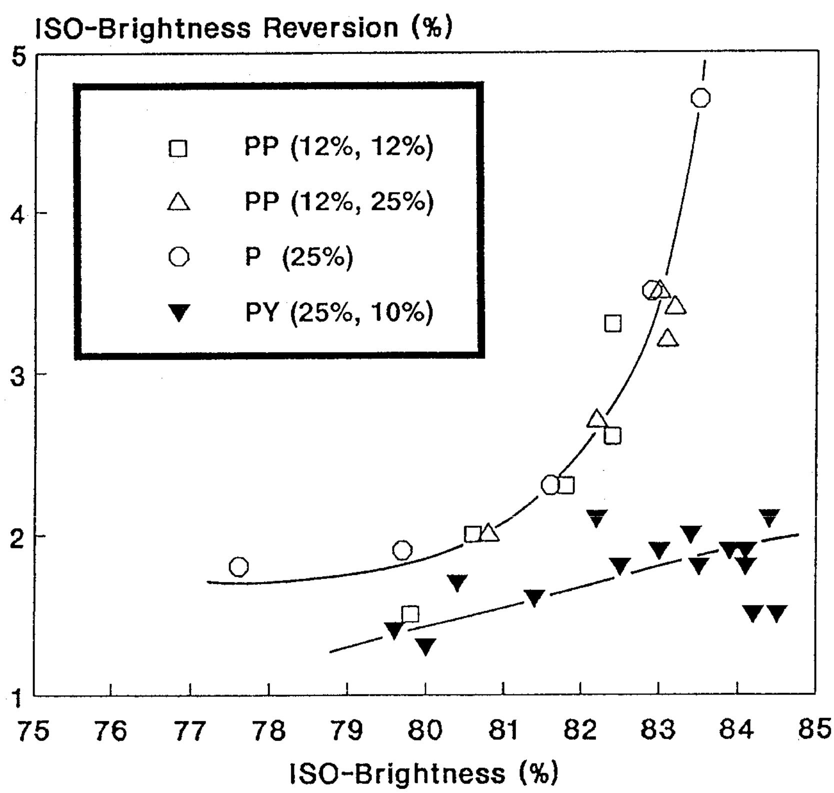


FIG. 14. BRIGHTNESS REVERSION OF THE BLEACHED PULPS AFTER THERMAL TREATMENT AS A FUNCTION OF ISO BRIGHTNESS BEFORE REVERSION. THE PULPS BLEACHED WITH THE PY SEQUENCE GIVE THE LOWEST REVERSION.

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**Résumé:** Plusieurs procédés à simple et à double stade de blanchiment de la pâte mécanique et chimécanique à des degrés de blancheur élevés sont comparés dans cette communication.
Les résultats du blanchiment en laboratoire obtenus avec une pâte CTM commerciale de bois de résineux ont été utilisés en tant que données d'entrée pour des calculs du bilan massique, qui ont été effectués au moyen du progiciel de simulation GEMS. les diagrammes de débit de la stratégie de redirculation de l'eau blanche de procédé sont décrits.
La séquence de blanchiment à double stade au peroxyde à haute consistance au premier stade est le procédé le plus rentable, en plus de donner la degré de blancheur maximal possible, une luminosité élevée, la teinte jaune la plus pâle possible et une inversion de brillance après le traitement thermique.

**Abstract:** Several processes used for bleaching mechanical and chemi-mechanical pulps at high brightness levels are compared: (1) single-stage peroxide bleaching (P) at high consistency (HC) and at medium consistency (MC) with and without recovery of the residual peroxide; (2) double-stage bleaching sequences such as peroxide followed by hydrosulphite (PY) and double-stage peroxide bleaching (PP) at medium consistency in each bleaching stage (MC-MC) and at medium consistency in the first stage and at high consistency in the second stage (MC-HC). Laboratory bleaching results obtained for a commercial CTMP pulp of a spruce/balsam mixture were used as the input data for mass balance calculations which were done using the computer simulation package GEMS. The process flow diagrams with the white water recirculation strategy are described. The processes are compared in terms of peroxide charge required to reach a given ISO-brightness level, the estimated bleaching costs, the maximum ISO-brightness values obtained as well as yellow shade, luminosity and brightness reversion of the bleached pulps after thermal treatment. It is shown that the double-stage bleaching sequence using peroxide at high consistency in the first stage and hydrosulphite at medium consistency in the second (PY) is the most cost-effective process in addition to giving maximum achievable brightness (84.2% ISO), highest luminosity (L• = 96.1), lowest yellow shade (b• = 5.51) and brightness reversion (△1.5%) after thermal treatment.

**Reference:** DESSUREAULT, S., LAFRENIERE, S., BARBE, M.C., LEDUC, C., DANEAULT, C. Bleaching processes for the production of mechanical and chemimechanical pulps of high brightness. *Pulp Paper Can* 95(7) T264-272. (July 1994). Paper presented at the 1991 Pacific Coast-Western Branches Joint Conference of the Technical Section, CPPA, at Whistler, BC, on May 16 to 18, 1991. Not to be reproduced without permission. Manuscript received April 5, 1991. Revised manuscript approved for publication by the Review Panel February 22, 1994.

**Keywords:** BLEACHING, BRIGHTNESS, CHEMICAL TREATMENT, CHEMIMECHANICAL PULPS, COMPUTERS, COSTS, DITHIONITES, EQUATIONS, HIGH YIELD PULPS, HYDROGEN PEROXIDE, INORGANIC SALTS, LUMINOSITY, MECHANICAL PULPS, REVERSION, SEQUENCES, SIMULATION, SULPHUR COMPOUNDS, YELLOWING.

INDUSTRY NEWS

# — BRIEFLY —

• Fletcher Challenge Canada has announced that it expects to curtail newsprint production at its Elk Falls mill by approximately 12 000 tonnes over the next two months because of a shortfall in orders. This is equivalent to eight days of combined production of the three newsprint machines at the mill on Vancouver Island.

— ENVIRONMENT —

## FF SOUCY INVESTS FOR FUTURE

RIVIERE-DU-LOUP, QC — FF Soucy & Partners and Company Ltd. has approved the construction of a wastewater biological treatment system in the amount of $13.5 million. The construction of the activated sludge system is scheduled to begin in August 1994 and be completed in the fall of 1995, in time for the company to meet the federal and provincial environment regulations. The engineering will be done by the firm BPR-Génivel of Québec City, QC.

— UNIONS —

## STORA WORKERS FEAR SHUTDOWN

HALIFAX, NS — A report in *The Financial Post* in June said that the union representing 800 workers at two Stora Forest Products Ltd. mills in Port Hawkesbury, NS, fears the pulp operations will shut down. At least $500 million in new technology is needed to ensure the long-term survival of any jobs. The company recently decided to spend $36 million on an enhanced treatment plant for its newsprint side only, a move the union says signals the end for the pulp operation.

— CONSTRUCTION —

## AVENOR CONTROLS EFFLUENT QUALITY

MONTREAL, QC — Avenor Inc. (formerly CP Forest) is building a $35-million effluent treatment system at its Gatineau, QC newsprint mill. An engineer-procure-construct (EPC) contract is in progress with Aquaflow Division of Ahlstrom Kamyr Inc. of New York supplying the effluent treatment system. Cowan, a division of SNC-Lavalin Inc., and ABGS Inc. are providing detailed engineering to Aquaflow. The construction will be handled by Kamyr Enterprises Inc.

Journal of Record, Technical Section, CPPA

# PULP & PAPER CANADA

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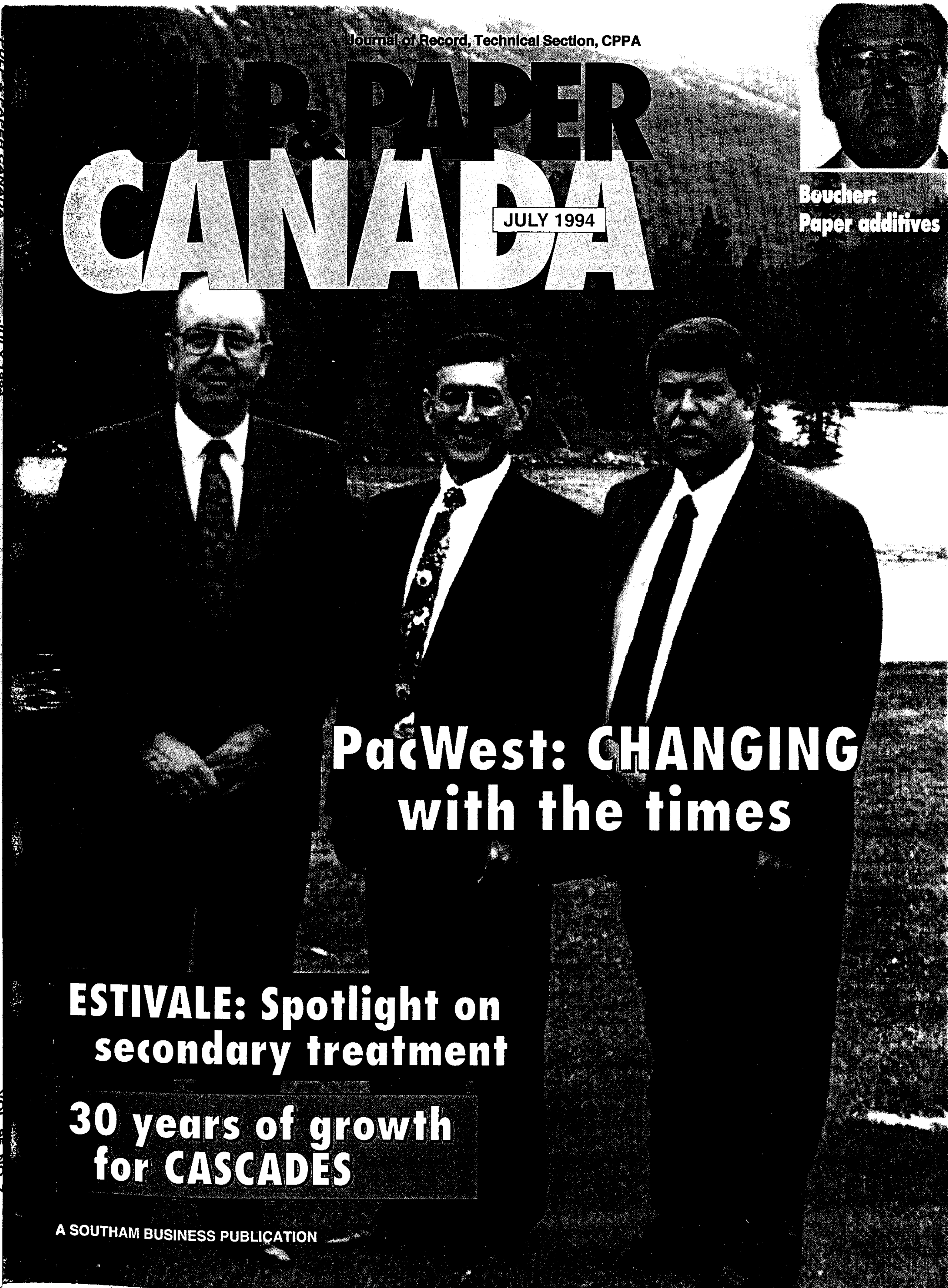

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