Evaluation of loblolly pine mechanical pulps for LWC paper

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ABSTRACT: Although the wood cost of loblolly pine (*Pinus taeda*) is lower than that of northern softwoods due to its fast growth rate and suitability for plantation harvesting, loblolly pine mechanical pulps tend to have poor quality and are mainly used in low-value grades such as newsprint. Our recent studies have shown that low-intensity refining or chemical pretreatments can significantly improve the mature pine pulp quality and make it possible to use this pulp in high-value grades like lightweight coated paper (LWC). In this report, we present our evaluation of the use of bleached low-intensity mature loblolly pine thermomechanical pulp, bleached mature pine chemi-thermomechanical pulp, and bleached juvenile pine thermomechanical pulp in LWC paper, focusing on basesheet structure and surface roughness as well as their effect on coating quality and printability. Results show that, compared to a control sheet using a commercial spruce/aspen bleached thermomechanical pulp, it is possible to use loblolly pine mechanical pulps in LWC furnish. However, pre-calendering is the key to reduce sheet porosity and surface roughness in order to attain good coating holdout and uniform coverage.

Application: Low-intensity refining or chemical pretreatments can significantly improve the quality of mature loblolly pine mechanical pulps and make it possible to be used in lightweight coated paper (LWC). However, pre-calendering is the key in papermaking to reduce sheet porosity and surface roughness in order to attain good coating holdout and uniform coverage.

Loblolly pine (*Pinus taeda*) has traditionally been used in low-value paper grades such as newsprint. Only a small portion of loblolly pine is used in value-added papers. Although the wood cost is lower than that of northern softwoods due to its fast growth rate and suitability for plantation harvesting, mature loblolly pine fiber has a relatively larger diameter and thicker fiber wall, as well as a higher percentage of darker latewood fibers, in comparison with spruce and balsam fir [1]. The use of loblolly pine in LWC furnishes is severely limited mainly because the basesheet tends to have high porosity and surface roughness, which negatively affects coating coverage and uniformity. The LWC paper quality is largely determined by the basesheet properties [2]. Basesheet for LWC should have good strength for runnability, good optical properties for printing, and good sheet structure/surface for coating quality and final paper/print gloss.

The use of juvenile loblolly pine has increased during the last decade at most southern pine paper mills [3–5]. Although the low pulp strength of juvenile wood may require more reinforcing pulp in certain paper grades [6], the fiber diameter and wall thickness of juvenile loblolly pine are reported to be comparable to those of mature spruce [1]. This may have some positive implications on paper structure and surface properties. However, the application of juvenile pine TMP in high-value added papers such as LWC and SC has not been reported.

Earlier studies on loblolly pine mainly focused on improving quality and reducing refining energy for newsprint furnish [4, 7–9]. In comparison to spruce/balsam fir, mature loblolly pine requires greater chemical and/or mechanical treatments to develop the pulp properties that originate from the collapse of the pine tracheids and expose sufficient fiber wall for bonding [9]. Sabourin et al. have studied the thermomechanical pulping properties of loblolly pine in modified refining schemes [4,7,8]. One study used the pressurized chip compression technique and the low retention, high temperature, high speed, "RTS" process to make newsprint furnish [7]. They found the RTS process reduced refining energy requirements by 15% while maintaining similar pulp and paper properties. However, the quality of the pine pulp was not as good as that of a spruce/fir mixture produced under identical conditions.

Recent studies at Paprican [10,11] showed that chemi-thermomechanical pulping and low-intensity refining of mature loblolly pine can significantly improve pulp quality. A light sulphonation treatment provides loblolly pine CTMP with strength properties intermediate between those of spruce TMP and mature pine TMP [10]. More importantly sulphonation also reduced the coarseness of the long fibers, which is in agreement with the earlier finding [9]. Reducing the refining intensity in the secondary refining stage (reducing disc speed from 1200 rpm to 900 rpm) provides mature loblolly pine TMP with more long fibers at the same freeness or bulk. Consequently, higher tear but slightly lower light scattering were observed. Also lower bulk and higher air resistance at the same long fiber content indicates that fibers of low-intensity TMP are more flexible than those of conventional TMP [11]. The above improvements in quality make it possible to use mature loblolly pine in high-value grades such as LWC paper; the central topic of this study.

In this report we investigated the possibility of using loblolly pine pulps in LWC paper, focusing on basesheet struc-

Pulp Type	L-BTMP	BCTMP	J-BTMP
Freeness (mL)	47	47	25
Refining energy (kWh/t)	5519	3702	4005
Chemical pre-treatment	-	Yes	-
Speed of the secondary refiner (rpm)	900	1200	1200
NaOH in bleaching (%)	3.5	2.5	3.5
H_2O_2 in bleaching (%)	3.5	2.9	3.5
ISO brightness (%)	70.0	72.6	71.2
Other bleaching conditions: 3% silicate, 0.2% DTPA, 0.05% $MgSO_4$, 20% consistency, 75°C for 3 hours.			

I. Differences in refining and bleaching conditions used for the three loblolly pine pulps.

ture and surface roughness and their impact on coating quality and printability. The bleached low-intensity mature loblolly pine thermomechanical pulp (L-BTMP), bleached mature pine chemi-thermomechanical pulp (BCTMP), and bleached juvenile pine thermomechanical pulp (J-BTMP) were produced in Paprican's TMP pilot plant. Each furnish was combined with kraft and clay filler to make LWC basesheets. We compared basesheet properties, coating, and printability to a control sheet using a commercial spruce/aspen BTMP (CM-BTMP) obtained from an eastern USA mill. Laboratory handsheets were made using a Dynamic Sheet Former (DSF). The DSF provides an intermediate step between a conventional British handsheet machine and a pilot paper machine. The DSF requires small quantities of pulp samples yet produces a large enough sheet to calender and print reproducibly [12–16]. Compared with the random fiber orientation of conventional handsheets, the oriented DSF sheets can provide information on paper surface and printability that suits well the purpose of furnish comparison in this study.

EXPERIMENTAL

Wood

Mature and juvenile loblolly pine chips were obtained from a mill located in the state of Louisiana, USA. The chips were screened at Paprican's pilot plant before processing.

Pulps

Three types of loblolly pine pulps were produced at Paprican's TMP pilot plant: bleached mature pine low-intensity thermomechanical pulp (L-BTMP), bleached mature pine chemi-thermomechanical pulp (BCTMP), and bleached juvenile pine thermomechanical pulp (J-BTMP). Researchers used an Andritz 22-1CP single disc refiner and an atmospheric variable speed Sprout-Bauer 400 double-disc refiner as the primary and secondary refiners, respectively. The chips were pre-steamed at 4.0 bars for 20 seconds before refining in the primary stage with about 1000 kWh/t specific energy consumption. The pulps were then further refined in the secondary refiner to a target Canadian Standard Freeness (CSF) of 20–50 mL. The rotational speeds of the primary and secondary refiner were 1800 rpm and 1200 rpm, respectively, unless otherwise specified.

Table I lists the pulps produced and the differences in refining and bleaching conditions used for preparing these three pulps. Note that the L-BTMP pulp was produced by reducing the secondary refiner speed from 1200 to 900 rpm. For pine CTMP, the chips were pre-steamed at atmospheric pressure for 15 min followed by impregnation with sodium sulfite, 16 g/L, $MgSO_4$, 0.5 g/L and DTPA, 10 g/L at pH 6. The impregnated chips were then cooked at 130°C for 3 min in a vapor-phase digester before refining. Bleaching of all pulps was preceded by chelation with 0.2% DTPA at 60°C for one hour.

Basesheet and coating

The pulps were screened on a Somerville screen (0.15 mm slots) before sheet making. A Dynamic Sheet Former (DSF, made by Noram, Pointe-Claire, Quebec), which has been described in detail elsewhere [12–16], was used to produce basesheets for coating. To simulate a 56g/m^2 LWC paper, a 39 g/m^2 DSF basesheet was made from a mixture of 40% northern bleached softwood kraft and 60% various mechanical pulps produced in Paprican's pilot plant as described above. The bleached softwood kraft was obtained from an eastern USA mill. For comparison, a 50/50 aspen/spruce commercial BTMP from the same mill was used to make control sheets. Clay filler was also added to the basesheet, amounting to 6% ash in the paper. For simulating commercial LWC paper, a pulp consistency of 0.3% and a DSF wire speed of 1000 m/min were used. After forming, the sheets were pressed in a laboratory two-roll press and then dried in a drum dryer; this procedure has been described elsewhere [13]. If necessary, the basesheet was pre-calendered before coating using a hard-nip calender to a Parker Print-Surf (PPS, S10) roughness of about 5–6 μm. Since the wire side of the DSF sheets was rougher than the top side, the surface properties reported in this paper refer to the top side of the DSF sheets.

The basesheet was pigment coated to a target of 8.5 g/m^2 per side using a cylindrical laboratory coater (CLC 6000) operating at a speed of 800 m/min. The coated paper was soft-nip calendered using the following conditions: two passes

Chemicals	Parts
70% Delaminated and 30% NO. 1 clay pigment	100
Ethylated starch	5
Styrene-butadiene-acrylate latex	10
Calcium stearate lubricant	0.4
Ammonium zirconium carbonate insolubilizer	0.1
Total solids content of 60%, pH around 8.5.	

II. Main components of the coating formulation.

with each side of the paper surface facing a heated hard roll once (80 °C), 300kN/m nip pressure, and at a speed of 50 m/min. **Table II** lists the main components of the coating formulation used in this study.

Testing

The pulps were screened on a Somerville screen (0.15 mm slots) before testing. The pulps were tested according to PAPTAC standard methods. The length weighted fiber length and long fiber coarseness were measured using an OpTest FQA Fiber Quality Analyser.

Coating holdout and uniformity was measured by scanning electron microscopy (SEM) and image analysis on the cross sections of coated papers, as described in detail by Allem [17]. The ink demand test (PAPTAC useful method L.6U) was conducted on coated samples softnip calendered to a Parker Print Surf roughness (PPS-S10) of 1.3–1.5 µm using a Prüfbau printability tester. The printing was performed at a pressure of 3.6 MPa and a speed of 3 m/s. The amount of ink transferred was calculated from the weight difference of the disk before and after printing. The prints were measured 12 hours after printing for print density, print gloss, and print-through using an Elrepho Datacolor 2000.

	Kraft	CM-BTMP	L-BTMP	BCTMP	J-BTMP
Freeness (mL)	538	28	47	47	25
Bauer-McNett fractions (%):					
R14	36.9	0.1	17.8	4.2	0.4
P14/R28	30.6	6.1	19.6	17.6	10.1
P28/R48	12.2	23.7	17.5	23.6	23.6
P48/R100	5.7	20.0	9.3	13.3	19.8
P100/R200	1.8	6.6	5.2	8.7	9.9
P200	12.8	43.5	30.5	32.6	36.2
Coarseness (mg/m):					
P14/R28	-	0.20	0.30	0.28	0.27
P28/R48	-	0.15	0.24	0.23	0.22

III. The characteristics of the pulps used in this study.

	CM-BTMP	L-BTMP	BCTMP	J-BTMP
Bulk, cm^3/g	2.50	2.63	2.75	2.56
Specific scatt., m^2/kg	78.3	55.3	56.8	59.0
Tensile index, N·m/g	39.3	40.6	39.3	37.4
Tear index, $mN \cdot m^2/g$	4.7	7.26	6.2	4.1
Burst index, $kPa \cdot m^2/g$	1.92	2.37	2.07	1.7
Gurley air resistance, s/100 mL	181.2	186.8	119.6	180.7

IV. The physical properties of the pulps used in this study.

The surface profile of the sheets was measured using a non-contact optical profilometer (ALTISURF 500). Five lines a half-centimeter apart from each other were scanned per sample. The frequency analysis results were presented by plotting the roughness against wavelengths that correspond to the scale of fiber width, micro-formation, and flocs.

The pore size distribution and pore diameter of the basesheet were measured with a mercury intrusion method using a Pore Sizer 9320 from Micromeritics.

RESULTS AND DISCUSSION

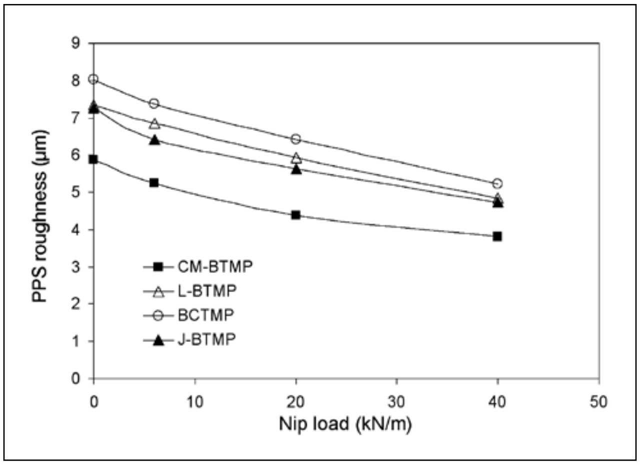
Pulp characteristics

Table III lists the characteristics of the pulps used in this study. As expected, the softwood kraft pulp had very high long fiber content but low fines. Among the four mechanical pulps, the commercial BTMP (CM-BTMP) had the lowest long fiber content but the highest fines since it was produced from a mixture of 50% hardwood and 50% softwood. L-BTMP had much higher long fiber content but lower middle fractions compared with BCTMP and J-BTMP. L-BTMP also had the least fines content among the four mechanical pulps but the fines content was only slightly lower than that of BCTMP. Among the three loblolly pine pulps, J-BTMP had very little R14 but the highest fines content. The coarseness for the long fibers of CM-BTMP was significantly lower than that of pine pulps. Interestingly, the coarseness of the long-fibers from the juvenile BTMP (J-BTMP) used in this study was very close to that from the BCTMP and L-BTMP of mature pine. Note that the juvenile TMP was refined to a relatively low freeness in order to develop pulp properties.

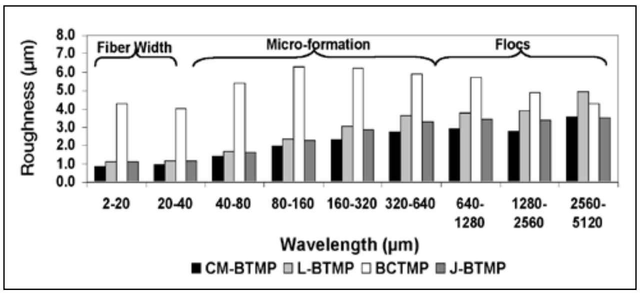
Table IV shows that corresponding to its high fines content, CM-BTMP has the highest light scattering coefficient. L-BTMP had slightly higher tensile index and significantly higher tear index; however, the light scattering coefficient was only slightly lower than the other two pine pulps. Despite its high long fiber content L-BTMP had a similar air resistance compared to the juvenile BTMP, suggesting these long fibers are well developed and flexible. J-BTMP had similar strength properties compared to CM-BTMP, but with a lower light scattering power.

Basesheet properties

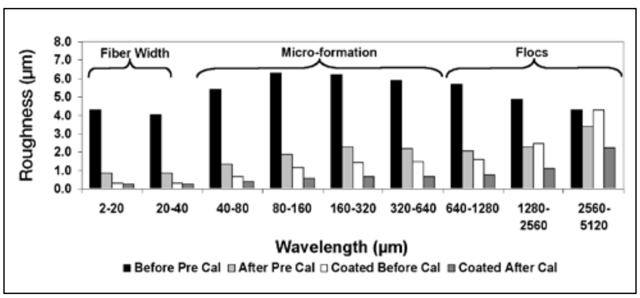
The LWC basesheet was prepared with a mixture of kraft, mechanical pulp, and clay fillers using the dynamic sheet former. **Figure 1** shows the initial PPS roughness and the calendering responses of these basesheets. The basesheet with BCTMP had the highest initial roughness of 8.1µm and the two other pine sheets had a roughness close to 7.3 µm. Since the basesheet with pine pulps had a PPS roughness above 7 µm, they were pre-calendered to a roughness between 5–6 µm by a hard-nip laboratory calender. Higher nip pressure (30 kN/m) was required to decrease the roughness of pine-containing sheets to the target roughness compared to the sheet with CM-BTMP (6 kN/m). This is necessary since CM-BTMP has many short fibers and fines filling the pores between long



1. Pre-calendering response for basesheets. The pre-calendering was conducted using a hard-nip calender at room temperature and 50 m/min.



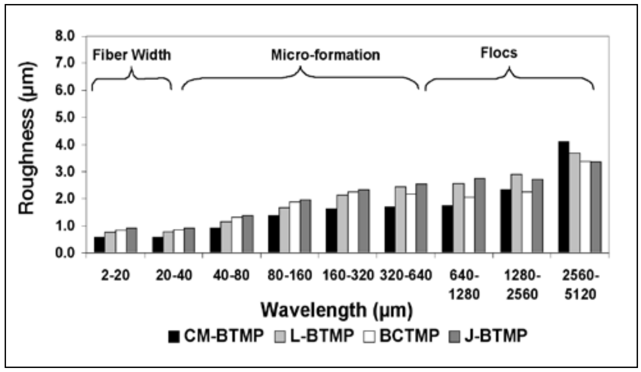
2. Surface profile of the basesheets before pre-calendering. Compared with the TMP-containing sheets, the basesheet with BCTMP had a higher roughness.



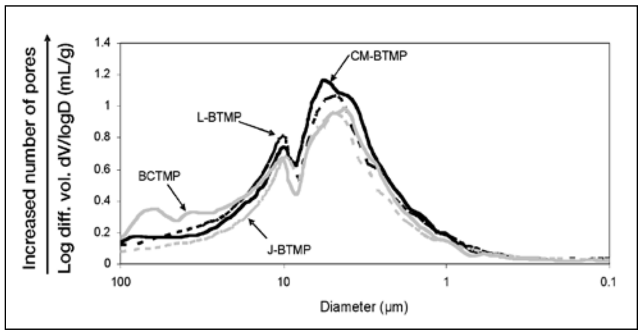
3. Pre-calendering significantly decreased the surface roughness of the basesheet with BCTMP.

fiber networks and thus produces a smoother paper surface.

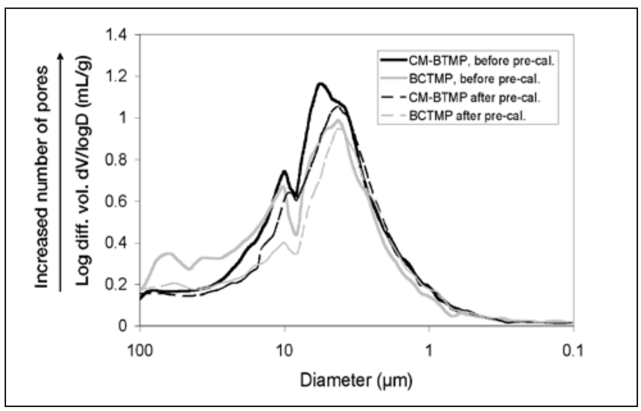
Figure 2 shows surface profiles of the basesheets before pre-calendering. Compared with the TMP-containing sheets, the sheet with BCTMP had a higher roughness, especially in the low wavelength of fiber and micro-formation ranges. This is in agreement with the PPS roughness measurements as shown in Fig. 1. Table III shows that BCTMP had much more long fibers but less fines than CM-BTMP and J-BTMP, which contributes to the higher surface roughness. On the other hand, although L-BTMP had more long fibers and less fines than BCTMP, its sheet was smoother than BCTMP sheet. This is most likely because the long fibers from L-BTMP are well developed and more flexible than those from BCTMP. Low-intensity secondary refining allowed more energy (Table I) to be consumed in long fiber development with less fiber cutting [11].



4. After pre-calendering, the basesheets with pine pulps had similar surface profile, just slightly rougher than the basesheet with CM-BTMP.



5. Pore size distribution of the basesheets before pre-calendering. Large-sized pores: BCTMP>L-BTMP≈ CM-BTMP>J-BTMP.



6. Change of pore size distribution before and after pre-calendering for the basesheets made with CM-BTMP and BCTMP. Basesheet with CM-BTMP had more large pores than the basesheet with BCTMP.

Figure 3 shows that pre-calendering significantly decreased the surface roughness of the basesheet with BCTMP, which is very important for coating uniformity. After pre-calendering, the three pine sheets were very similar in surface roughness profile, just slightly rougher than the CM-BTMP sheet (**Fig. 4**).

Besides the smoothening effect, another important function of pre-calendering is to decrease the average pore size of the basesheets by densification, which is beneficial for the coating holdout and coverage. **Figures 5** and **6** show the mercury intrusion measurements of pore size distribution before and after pre-calendering, respectively. Before pre-calendering, the order of the large-sized pores for these basesheets is: BCTMP>L-BTMP~CM-BTMP>J-BTMP. Research has shown that it is the large-sized pores that cause coating penetration and thus reduced coating coverage at a given coat weight [18].

After pre-calendering, the three sheets containing pine pulps had very similar pore size distributions. All were much lower than those before pre-calendering, especially at the ranges of large-sized pores (>10µm). Figure 6 shows the change of pore size distribution for the basesheets before and after pre-calendering. Since the three sheets with pine pulps had a similar pore size distribution, only the basesheet with BCTMP was compared to the CM-BTMP sheet in Fig. 6 to simplify the graph. As discussed earlier in this section, the sheet with CM-BTMP required a much lower nip pressure than the sheets with pine pulps (6 kN/m vs. 30 kN/m) to reach a PPS roughness of 5–6 µm. As a result, the sheet containing CM-BTMP had more large-sized pores than the other three sheets containing pine pulps after pre-calendering. This is confirmed by the higher bulk and air permeability of the CM-BTMP sheet as compared to the sheets with pine pulps (**Table V**). This implies that the sheet with CM-BTMP should also be pre-calendered at a higher nip pressure to reduce its pore size distribution. Appropriate pre-calendering is an effective way to reduce roughness and porosity of the basesheets with pine pulps. This is one of the key unit processes to improve basesheet quality with pine pulps.

Table V lists physical properties for the basesheets after pre-calendering. It shows that the sheets containing pine pulps had similar bulk, PPS roughness, and light scattering. The air permeability of the sheet containing juvenile pine BTMP is slightly lower than the other two pine sheets. Note that all the sheets had similar light scattering results although the light scattering of the CM-BTMP is much higher than the pine pulps as shown in Table IV. Table V also shows that the sheets with pine pulps had similar strength properties as that with CM-BTMP, except that the sheet with juvenile BTMP had a lower fold number.

DSF sheet	CM-BTMP	L-BTMP	BCTMP	J-BTMP
Bulk, cm^3/g	2.35	2.14	2.14	2.19
PPS roughness, µm	5.2	5.3	5.5	5.0
PPS air permeability, mL/min	404	149	152	100
Specific scattering, m^2/kg	54.0	52.6	52.0	53.5
ISO brightness, %	64.4	66.2	68.2	68.4
ISO opacity, %	83.0	80.7	79.5	80.4
Tensile Index, Nm/g	45.9	42.9	39.6	43.3
Tear Index, $mN.m^2/g$	8.1	9.1	7.3	7.1
Burst Index, kPm^2/g	3.1	2.6	2.7	2.6
MIT fold	50	55	68	35

V. Physical properties of the basesheets after pre-calendering.

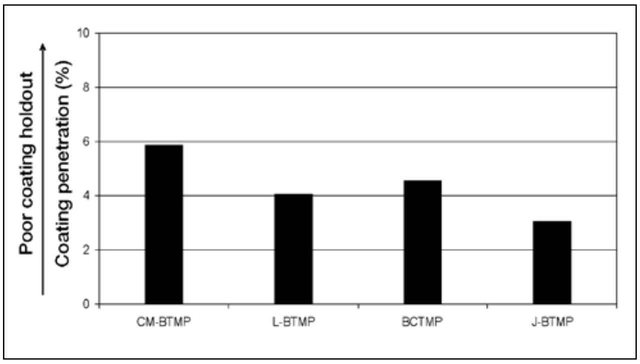
DSF sheet	CM-BTMP	L-BTMP	BCTMP	J-BTMP	Typical LWC
Bulk, cm^3/g	1.13	1.04	1.14	0.97	1.1
PPS roughness, µm	1.34	1.41	1.54	1.30	1.2-1.9
PPS air Permeability, mL/min	4.6	4.2	3.8	3.7	2-4
ISO brightness, %	67.1	68.2	72.9	69.2	70-72
ISO opacity, %	89.4	87.0	84.6	87.4	90
Gloss 75, MD, %	40.2	41.2	39.3	43.5	50

VI. Physical properties of the coated paper after soft-nip calendering.

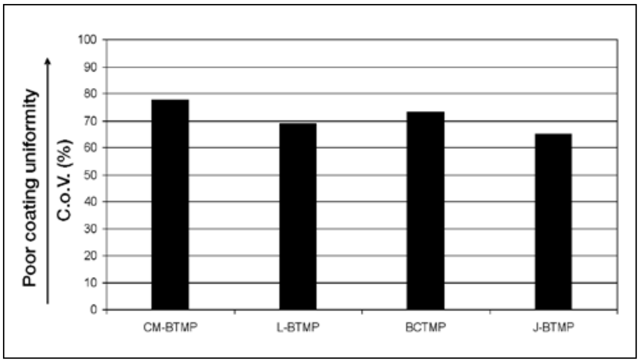
Coating

Coating holdout is the ability of coating to stay on paper surface. It is very important for coated paper because a paper with poor coating holdout needs more coating to achieve the same quality, resulting in an increase in production cost and decrease in coating uniformity. The coating holdout is mainly determined by the number of large-sized pores in the basesheet [18]. In this study, the coating penetration was defined as the pigments penetrating more than two fiber walls deep into the basesheet, and was measured by scanning electron microscopy (SEM) and image analysis on the cross sections of the coated papers, as described in the experimental section. As **Fig. 7** shows, all sheets had acceptable coating holdout. The coating holdout of the sheet with CM-BTMP was poorer than the three pine sheets because it contains more large-sized pores (Fig. 6) and has a higher air permeability (Table V). The SEM images analysis also showed that the four sheets had similar coating coverage around 90%.

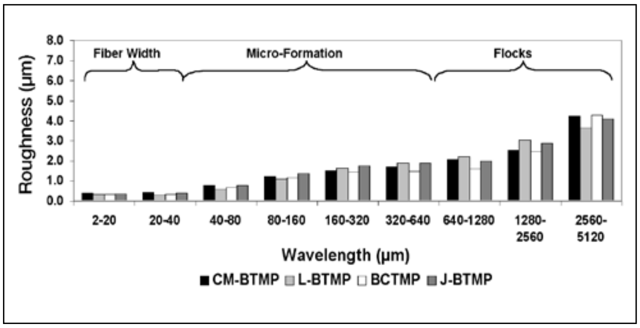
Coating uniformity is an important parameter controlling the color print quality in high-speed offset printing of LWC



7. All sheets had acceptable coating holdout.



8. The sheets containing pine pulps had similar coating uniformity and are marginally better than that of the sheet with CM-BTMP.

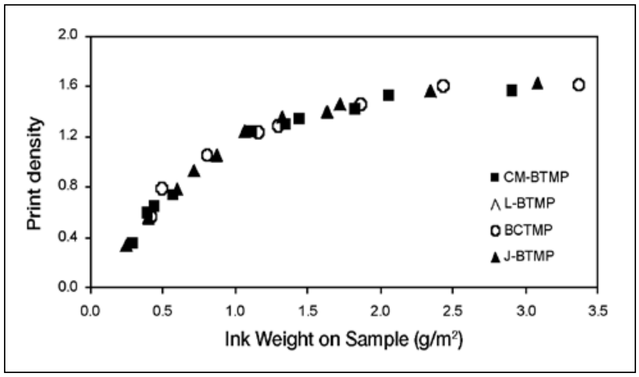


9. Surface profiles of the coated sheets before calendering. The sheets with pine pulps had very similar surface profiles to the sheet with CM-BTMP. This implies that there was negligible surface roughening/puffing from pine fibers when contacted with water in the coating process.

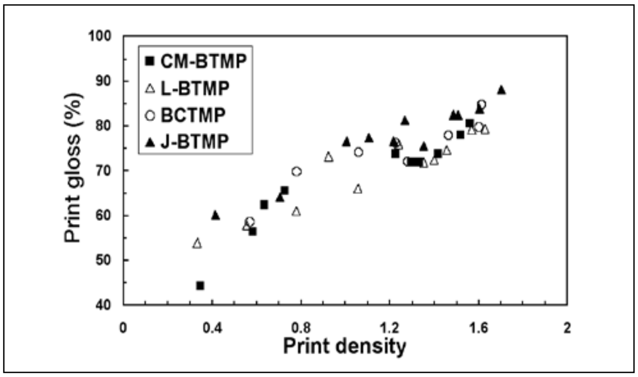
paper. Coating uniformity is affected by many factors, including coating process, coating formulation, and basesheet properties. Among them, basesheet properties such as roughness, compressibility, and porosity have the most significant effects on coating uniformity. In this paper, we used the coefficient of variation (C.O.V.), a ratio of standard deviation over mean coating thickness, to characterize the coating thickness uniformity. A lower C.O.V. indicates a more uniform coating thickness distribution. **Figure 8** shows that the sheets containing pine pulps had similar coating uniformity and were marginally better than the sheet with CM-BTMP. This could be explained by the fact that more coating penetrated into the basesheet containing CM-BTMP than the ones with pine pulps. Overall, sheet with low-freeness J-BTMP had the best coating quality.

Figure 9 shows the surface profile of the coated sheets before soft-nip calendering. The sheets with pine pulps still had very similar surface profile as that of the sheet with CM-BTMP. This implies that there was negligible surface roughening/puffing from the pine fibers when contacted with water in the coating process.

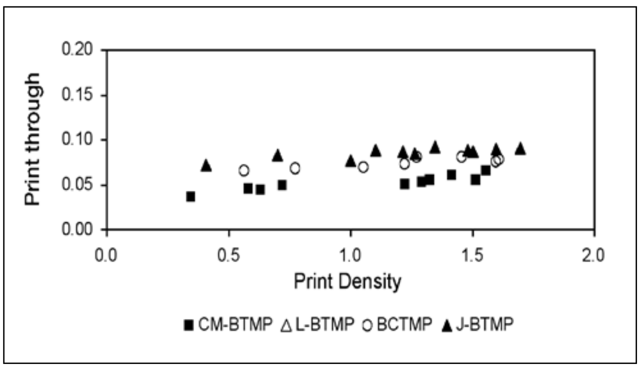
All four sheets had similar PPS roughness and responded similarly to nip pressure on a soft-nip calender. **Table VI** lists the coated paper properties after calendering. Also included in the table are properties of a typical 56 g/m^2 LWC paper tested in our lab. Similar properties were obtained except



10. Similar ink demand for these four coated LWC sheets.



11. Pint gloss for these four coated LWC sheet.



12. CM-BTMP sheet had a slightly lower print through than the sheets containing pine pulps, mainly due to its higher opacity at a lower brightness.

brightness and opacity. The difference in opacity is clearly related to the difference in brightness. The paper containing CM-BTMP had the lowest brightness but the highest opacity, while the sheet with BCTMP had the highest brightness but the lowest opacity. Comparing with the typical LWC paper, similar properties were achieved except a lower gloss, which is most likely a result of less efficient calendering in the lab.

Printability

The printability of a paper is its ability to receive ink and produce a high-quality image. We used the Prüfbau ink demand test which evaluates the ink demand, print gloss, and print through at a given print density. A good printing paper has lower ink demand, less print through, and higher print gloss at a given print density. **Figures 10-12** show that these sheets had a similar print gloss and ink demand. However, the sheet with CM-BTMP had better print through than the three pine sheets. The print through was mainly a function of paper porosity and opacity [19]. Since the coated LWC sheets all had a very low porosity as indicated by the air permeability in Table VI, the higher opacity of the sheet with CM-BTMP, at the expense of lower brightness, contributes to its lower print through, compared with the paper with pine pulps. In general, the print through of all these four coated papers is considered acceptable.

SUMMARY AND CONCLUSIONS

We evaluated the use of three loblolly pine mechanical pulps in LWC paper in terms of basesheet properties, coating quality, and printability. The results have shown:

1. It is possible to use these loblolly pine mechanical pulps as a LWC furnish, but pre-calendering is the key to reduce sheet porosity and surface roughness, a requirement to get good coating holdout and uniform coverage. Compared with the control sheet using a commercial spruce/aspen BTMP, sheets with pine pulps had a higher porosity and surface roughness before pre-calendering. Pre-calendering was particularly important for decreasing the roughness and pore size distribution of the sheet from mature pine BCTMP.
2. The basesheet with low intensity L-BTMP was smoother than the basesheet with BCTMP despite having more long fibers than BCTMP. This suggests that long fibers of L-BTMP are more flexible and better developed.
3. Compared with mature pine pulps, low-freeness juvenile BTMP in LWC paper results in similar tensile and tear but a lower fold number. However, it had the best coating quality among the three pine pulps. **TJ**

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REFERENCES

1. Harris, G., "Comparison of Northern Softwood and Southern Pine Fiber Characteristics for Groundwood Publication Papers." *Tappi J.*, 76(6), 55–61 (1993).
2. Pylkkö, J., "Mechanical Base Paper", in *Papermaking Science and Technology 11. Pigment coating and surface sizing of paper*, J. Gullichsen, H. Paulapuro, and E. Lehtinen, eds., Fapet Oy: Helsinki, Finland. pp. 81pp (2000).
3. Roberson, T., "Southern Pine Beetles Wreak Havoc on Southern Pulp Operations." *Pulp & Paper*, 74(10), 13 (2000).
4. Sabourin, M., Vaughn, J., Frith, M., Lauritzen, J., Wiseman, N. and Fraser, T., "Characterization of Paper Properties from Spruce and Pine Thermomechanical Pulps – Effect of Fefining Intensity." *Pulp & Paper Canada, 104*(4), 37–42 (2003).

INSIGHTS FROM THE AUTHORS

Although the wood cost of loblolly pine (*Pinus taeda*) is lower than that of northern softwoods due to its fast growth rate and suitability for plantation harvesting, loblolly pine mechanical pulps tend to have poor quality and are mainly used in low-value grades such as newsprint. Our recent studies have shown that low-intensity refining or chemical pretreatments can significantly improve the mature pine pulp quality and make it possible to be used in high-value grades like lightweight coated paper (LWC). This study verifies this using the DSF oriented sheets and compare to a commercial furnish of LWC.

It required a lot of experience to correctly simulate the mill papermaking conditions using the DSF machine. That was the most challenging part of our research.

Results show that, compared to a control sheet using a commercial spruce/aspen bleached thermomechanical pulp, it is possible to use loblolly pine mechanical pulps in LWC furnish. However, pre-calendering is the key to reduce sheet porosity and surface roughness in order to attain good coating holdout and uniform coverage. Mechanical pulp producers in the southern U.S. might use information gained from this work to produce high-quality mechanical pulps from loblolly pine for value-added papers like LWC and SC.

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5. Myers, G.C., "Thermomechanical Pulping of Loblolly Pine Juvenile Wood." *Wood and Fiber Science*, 34(1), 108–115 (2002).

6. Jackson, M. "The Interaction of Wood Species and Wood Quality with TMP Process – A Review." Proceedings: *TAPPI Pulping Conference*. Montreal, QC, 1998, (TAPPI Press) 455–465.

7. Sabourin, M., Vaughn, J. and Wiseman, N. "Industrial Scale Evaluation of Low Retention, High Temperature, High Speed (RTS) TMP Pulping of Southern Pine." Proceedings: *2001 International Mechanical Pulping Conference*. Helsinki, Finland, 2001, Vol. 2, 341–352.

8. Sabourin, M.J., Vaughn, J., Wiseman, N., Cort, J.B. and Galatti, P. "Mill Scale Results on TMP Pulping of Southern Pine with Pressurized Chip Pretreatment." Proceedings: *87th PAPTAC Annual Meeting*. Montreal, 2001, Vol. C, C9–C16.

9. Janknecht, S., Dessureault, S. and Barbe, M.C. "Comparison of Loblolly Pine Mechanical and Chemical Pulping Processes, Pulp Properties, Process Features and Pulp Production Cost." Proceedings: *1990 Pulping Conference*. Toronto, Ontario, 1990, (TAPPI Press) Vol. 2, 695–715.

10. McGarry, P. and Heitner, C., "Southern Pine Bleached Chemi-Thermo-mechanical Pulps: A Comparative Evaluation of Pulp Properties", *PPR* (2004).

11. Miles, K. and Omholt, I. "Improving the Strength Properties of TMP." Proceedings: *2003 International Mechanical Pulping Conference*. Québec City, QC, Canada, 2003, (PAPTAC) 179–186.

12. Sauret, G. and Lanvert, J., "Aperçus sur la Fabrication de papier Journal au Laboratoire." *Technique et Recherches Papetières*, 43(5), (1965).

13. Amiri, R., Silveira, G.D. and Wood, J. R., "Evaluating Pulps for Newsprint and Mechanical Printing Papers in Terms of Their End-use Requirement." *J. Pulp & Paper Sci.*, 19(1), J26–32 (1993).

14. Anczurowski, E., Jones, A.Y. and Rutland, D.F., "Simulation of Fourdrinier Papermachine Forming in the Laboratory." *Pulp & Paper Canada*, 84(12), T283 (1983).

15. Bernard, E. and Bouchayer, H., "Parameters de Fabrication Affectant les Caractéristiques de papiers pour Ondulé." *ATIP*, 4(29), 113 (1975).

16. Charles, L.A. and Waterhouse, J.F., "The Effect of Supercalendering on the Strength Properties of Paper." *J. Pulp & Paper Sci.*, 14(4), J59 (1988).

17. Allem, R., "Characterization of Paper Coatings by Scanning Electron Microscopy and Image Analysis." *J. Pulp Paper Sci.*, 24(10), 329–336 (1998).

18. Zou, X. and Zhou, Y., "Application of High-yield Pulps into Wood-free Coated Papers." Proceedings: *2003 Spring Technical Conference and Exhibit*. Chicago, IL, 2003, (TAPPI Press) Session 42, 11pp.

19. de Grace, J.H., "The Print-through Propensity of Newsprint." *JPPS*, 19(5), J208–213 (1993).

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