The Effects of Certain Chemical Additives on the Deresination of Trembling Aspen in Kraft Pulping

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DERESINATION OF TREMBLING ASPEN IN KRAFT PULPING

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ABSTRACT

The effects of five chemical additives on the deresination of aspen wood during kraft pulping and washing were investigated. Without additives, only about half of the potentially saponifiable wood resin was saponified in the digester. For deresination during pulping and washing, the additives could be ranked according to their effectiveness as follows: distilled tall oil > Canadian tall oil (acid No. 131) > gum rosin > abietic acid, at charges of 1 to 3% on OD wood. A commercial surfactant formulation was found not to be cost effective.

INTRODUCTION

Poplar trees (genus _Populus_) are Canada's most abundant[1] and yet underused hardwood resource. As supplies of prime softwood timber near some mill sites diminish, considerable efforts have been and still are being made to use this genus more effectively[2]. The most abundant species of poplar in Canada is trembling aspen- (_Populus tremuloides_ Michx.), which for many years has been pulped as a single species using chemical and semi-chemical processes[3]. This species is most commonly pulped by the kraft process and, provided measures have been taken to avoid pitch problems[4-8] and excessive decay and discoloration[9], success has been achieved in making high quality hardwood market kraft pulp that is sufficiently

low in extractives that it can be used in products requiring high water absorbency.

Up to the year 1990 and beyond, there is expected to be a substantial increase in North American usage of relatively low-cost hardwoods such as aspen[10-13]. To remain competitive, companies using aspen are being forced to strive for consistently high pulp quality, particularly in the face of the challenge from the rapidly growing monocultures of Eucalyptus.

In striving for better quality, deresination and associated pitch problems are of concern to kraft mill personnel. Generally, aspen is a hardwood that has a relatively high extractives content[5,14,15]; other genera of which this is true are Betula (birch) and Tilia (basswood). This is partly the reason for the numerous reports of pitch problems when using birch and aspen. However, the amount of extractives may not be as important as their composition; fatty acids are converted to soaps and, if sufficient energy (heat, turbulence) and alkali are provided, the saponifiable neutrals can be converted to amphipathic soaps. The soaps then act as natural surfactants and help in the removal of unsaponified resins, by a complex non-equilibrium process of emulsification and solubilization.

It is therefore an advantage to have a high ratio of saponifiable-to-unsaponifiable wood resin, although other naturally-occurring surfactants, such as fragments of lignin, are also thought to be involved in resin removal. However, if we consider just the wood resin, it was shown that aspen has a low saponifiables-to-unsaponifiables ratio; in one case[6] it was 1.4:1, and more recently a ratio of 2:1 was reported[14]. For good deresination it has been estimated that the ratio should be about 3:1[7]. These ratios compare unfavorably with most pine species, which have a ratio of about 10:1, and may account for why pitch problems have been associated with the pulping of aspen.

An important difference between pine and the hardwoods, such as aspen, is that the latter contain only traces of resin acids[16-17]. If present in the wood, resin acids are converted to sodium

salts in the kraft mill digester and, although dextropimaric and levopimaric acids remain insoluble, the sodium salts of abietic, neoabietic and isodextropimaric acids readily dissolve. Importantly, the soluble resin acids act as co-surfactants with the fatty acid soaps forming mixed micelles, and for mixtures of sodium oleate (fatty acid) and sodium abietate there is an increase in the solubilization capacity of the micellar mixture, with the highest solubility occurring at a molar ratio of 1:1[18-20]. Because aspen contains almost no resin acids, this synergistic solubilization of the unsaponifiable resins does not occur.

It is possible to solve the problems of a low saponifiables-to-unsaponifiables ratio and a lack of resin acids by adding these materials during processing. In the kraft pulping of birch[7] and aspen, softwood tall oil has been used with success; however, the increased amounts of soap in the pulp mill may lead to increased brownstock defoamer consumption and increased evaporator scaling rates[21] if the soap is not skimmed at an intermediate stage of black liquor evaporation. The addition of resin acids to a kraft mill digester has been tried in Finland[22], but to our knowledge the results were never reported. The potential advantage of using resin acids is that they have been found in only trace amounts in the many analyses of pitch deposits that have been carried out in our laboratory[23,24] and, therefore, should not contribute to pitch problems.

In addition to using the natural surfactants, such as the soluble resin and fatty acid soaps, there are kraft mills in Europe and North America that have used synthetic surfactants to help in deresination.

The work in this report had four objectives:
. To improve our understanding of the deresination of aspen.
. To determine the effectiveness of tall oils in deresination and, in particular, to determine whether Canadian tall oils, which tend to have low acid numbers (e.g., 120-150), could be substituted for the more expensive Southern USA tall oils which have higher acid numbers.

. To determine whether resin acids could be used to deresinate
  aspen.

. To determine whether a commercial surfactant formulation current-
  ly used in North America is economically effective at improving
  deresination.

     The concept of evaluating the effectiveness of various addi-
tives on the deresination of aspen originated several years ago.
Initial experiments were conducted with a Canadian tall oil, a
Southern USA tall oil and a rosin size. This preliminary work led
to the more detailed investigations described in this paper.
Because the results of this earlier work complement and strengthen
some of our conclusions, they have been included toward the end of
the present report in a section entitled "Earlier Work".

                              METHODS

Materials

     The following chemical additives were used:

. Abietic acid, practical grade, ICN Pharmaceuticals, Inc.,
  Plainview, New York.

. Crude Canadian tall oil (acid no. = 131; 25.1% neutrals; 19.0%
  unsaponifiables; 1.8% water). A 20% solution was prepared
  according to the method of Farley[25].

. Doubly distilled tall oil (Sylvatal 40 DD, Sylvachem, Port St.
  Joe, Florida), acid no. = 185, containing 2.9% neutrals, of which
  1.9% was unsaponifiable. A 20% solution was prepared using the
  method of Farley[25].

. "M" Gum rosin, FRP Company, P.O. Box 349, Baxley, Georgia 31513,
  USA.

. Synthetic surfactant formulation: a proprietory ethoxylate/
  sulphonate blend, Hart Chemical Limited, Guelph, Canada.

Each additive was well mixed with the cooking liquor and then pour-
ed into the bomb digester containing a weighed amount of chips.

     The following solvents were used for extraction of the resin:

. Acetone, and ethyl ether, "High Purity Solvent", American Burdick
  & Jackson.

. Methanol, A.C.S. reagent grade, Anachemia.

. Petroleum ether (b.p. 37-56°C), Fisher Scientific Co.

Wood Sampling and Preparation

Two aspen trees of similar height were cut from a mature stand
in eastern Ontario and immediately transported to the laboratory.
The logs were cut into four-foot bolts and stored in a freezer at
-20°C to ensure minimal change in the extractives. When required,
the logs were hand debarked, chipped and screened. The chips were
thoroughly mixed and stored in a freezer at -20°C. A detailed
analysis of the wood and bark extractives has been reported sepa-
rately[14], but the mixed chip supply was analyzed as follows.
Freeze-dried chips (3-11 g) were weighed into double thickness
extraction thimbles and extracted for 18 h with 200 mL acetone.
The freeze-dried extract was fractionated into weak acids (pK_a
>5), strong acids (pK_a < 5) and neutrals, using a DEAE-Sephadex
ion-exchange column[26,27]. The neutrals were saponified using
the American Oil Chemists' Society method Cd-6-38, and then sepa-
rated into acids and neutrals on an ion-exchange column.

Pulp Preparation

The chips were divided into 200 g portions and cooked in 2 L
bombs immersed in an oil bath. The following conditions were
observed for all kraft cooks:

Liquor:wood (excluding moisture)	= 4:1
Sulfidity (%)	= 25.1
Cooking temperature (°C)	= 170
Time to temperature (min)	= 90
Time at temperature (min)	= 150
Active alkali charge (% on OD wood)	= 14.0
Yield (%)	= 56.8-55.4
Kappa number	= 14.6-17.0

Pulp Washing

Immediately on completion of the cooks, a 200 mL sample of hot black liquor was taken from the combined stirred digester contents, filtered through a coarse cellulose fiber filter (Whatman 202) and kept for analysis.

After the black liquor had been drained, the cooked chips were disintegrated and washed four times to simulate the conditions of brownstock washing in a mill, as follows:

First Wash: Distilled water (4 L; 60°C; adjusted with NaOH to pH 10) was added to the cooked chips and they were disintegrated for 3 minutes using a Cowel's Dissolver. The resultant pulp was filtered under gravity through a 200-mesh screen, and an aliquot (3.5 L) of the filtrate was collected.

Second Wash: Distilled water (1.5 L; 60°C; adjusted with NaOH to pH 10) was added to a portion of the filtered pulp (450 g wet). After mixing the suspension for 30 minutes, while maintaining the temperature at 60°C, the pulp was filtered under vacuum through a 100-mesh screen, and 1.65 L of filtrate were collected.

Third Wash: The procedure for the second wash was repeated but using 280 g of wet pulp and 1 L of distilled water. One litre of filtrate was collected.

Fourth Wash: The procedure was repeated, using 140 g of wet pulp and 1 L of distilled water.

The filtrate from each wash was filtered (Whatman 202), stored at 4°C, and analyzed within two days. The pulp samples were freeze-dried for 48 h, then stored in a freezer.

Extraction and Analysis of the Filtrates

The resins in the strong and weak black liquor samples (filtrates) were extracted by the procedure of Saltsman and Kuiken [28]. The freeze-dried extracts were fractionated using the methods described for fractionating the chip extractives [26,27].

Extraction and Analysis of the Pulp

Freeze-dried pulp samples (3-11 g) were weighed into double-thickness extraction thimbles and Soxhlet-extracted for 18 h with 200 mL of acetone. The acetone was removed using a rotary evaporator, and the weight of the extract was determined after freeze drying. The acetone extracts were fractionated into weak acids, strong acids, and neutrals[26,27].

RESULTS AND DISCUSSION

Deresination Without Additives

Cooks were made without additives to determine whether all the saponifiable resins, as determined by the American Oil Chemists' Society method Cd-6-38, could be saponified in a laboratory diges-ter. Assarsson[7] has reported that unpublished work with Akerlund on birch pulp has shown that although the triglycerides are completely saponified in kraft pulping, three quarters of the wood waxes remain unaffected in the pulp. Studies of birch indicate that esters of the cycloartenol type, which also exist in aspen[14], have particularly slow, homogeneous saponification rates[7]. Samples of freeze-dried chips and freeze-dried digester contents from a single kraft cook were extracted. As shown in Table 1, when the chip extractives were saponified in the labora-tory, 0.44% remained unsaponified; however, when the same extrac-tives were cooked in a digester, 0.22% of the potentially saponifi-able extractives remained unsaponified. Therefore, aspen should be even more difficult to deresinate than results of extractives analyses[14] would suggest.

As the work reported here was carried out over a period of one year, cooks were routinely made to determine whether any changes were occurring in the wood that would affect deresination. Despite the chips being in a freezer at $-20°C$, where neither chemical nor biochemical reactions would be expected to proceed very rapidly, changes did occur in the deresination behavior when the chips were

TABLE 1

A Comparison Between the Amounts of Resin Remaining Unsaponified
After a Laboratory Saponification and After a Kraft Cook.

	Unsaponified Resin (% w/w freeze-dried sample
Laboratory Saponification (chip extractives)	0.44
Kraft Cook (pulp plus black liquor extractives)	0.66

TABLE 2

Effect of Chip Storage for 6 Months at -20°C on Deresination During
the Kraft Pulping of Aspen.

	Neutral Resin in Black Liquor (% w/w freeze-dried wood)	Neutral Resin on Washed Fibers (% w/w freeze-dried wood)
Fresh Chips	0.36	0.68
Stored Chips	0.15	0.58

cooked (Table 2).   Therefore, in any of the comparisons between
different chemical additives, a blank cook with no additives was
made.

Effects of Natural (Wood-Based) Chemical Additives on Deresination

(1)   Removal of Total Extractives in the Digester and Washers.

It has been suggested that 1.5-2.5% tall oil (based on OD
wood) should be sufficient to ensure a good degree of resin removal
in the kraft pulping of European birch[7].   A similar charge was
chosen for the various additives in Figure 1.   It should be kept
in mind, however, that, for the resin acid additions, lower dosages
would probably have to be used in a mill as both pure and impure
supplies of resin acids are more expensive than tall oil.

Figure 1 shows the effects of various concentrations of four
wood-based additives on the percentage acetone extractives that
remain with the fibers and fines after a kraft cook and four stages
of laboratory washing.   As the concentration of each additive
increased from zero to 3% there was an improvement in the deresina-
tion of the pulp.   For all the additives except abietic acid, the
greatest reduction occurred on the addition of 1%, and successive
increments of 1% offered less advantage.   It is clear that the
distilled tall oil (DTO) was the most effective at reducing the
total fiber extractives, but there may also be an advantage to be
gained by using a Canadian tall oil for deresination.   Abietic acid
was not as effective as the tall oils at the concentrations tested
here.

Based on the work of Assarsson[7], the effectiveness of a
particular additive is likely to be related to its saponifiable-to-
unsaponifiable ratio.   However, in the case of abietic acid, whose
unsaponifiable content is very low, no significant improvement in
deresination was observed (Figure 1).   On the other hand, the
Canadian tall oil with its substantially higher level of neutrals
was considerably more effective.   It appears, therefore, that, in
addition to Assarsson's ratio, the actual composition of the resin
plays an important role in the solubilization process.
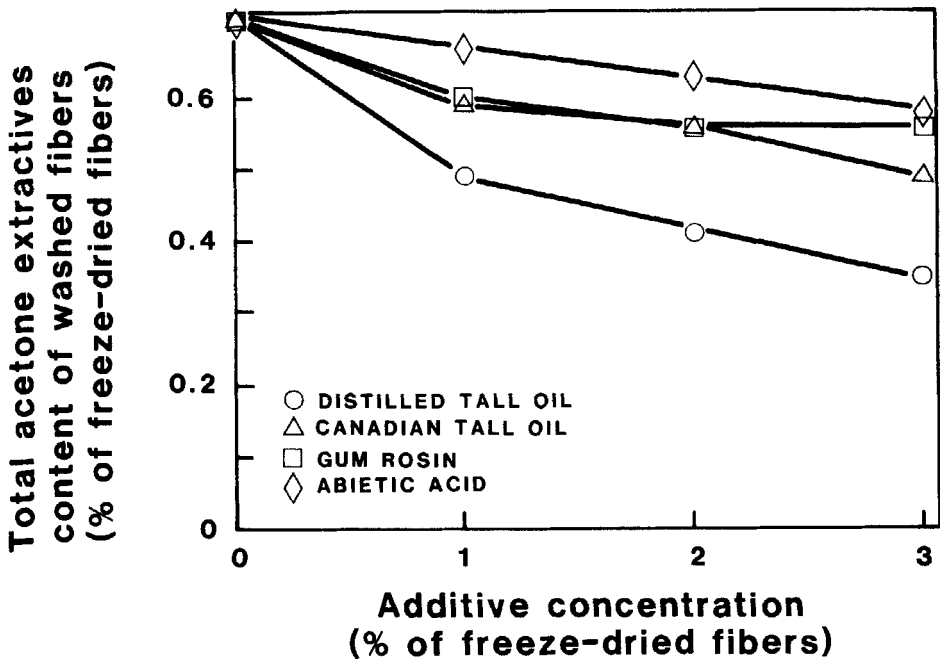
Figure 1: Total acetone extractives content of washed fibers
           versus additive concentration for four additives.   It
           required a 3% charge of Canadian tall oil to achieve the
           same deresination that the distilled tall oil gave at a
           1% charge.

(2) <u>Resin Removal in the Digester</u>.

     The upper set of curves (shaded symbols) in Figure 2 gives the
concentration of extractives in the black liquor as a function of
the additive concentration for each of the different additives.
All of the additives used are extractable themselves, and this
accounts for much of the increase in black liquor extractives with
increasing additive concentration.

     The lower set of curves (open symbols) in Figure 2 shows the
amounts of neutrals in the stirred black liquor immediately at the
end of a cook for different concentrations of the various additives.
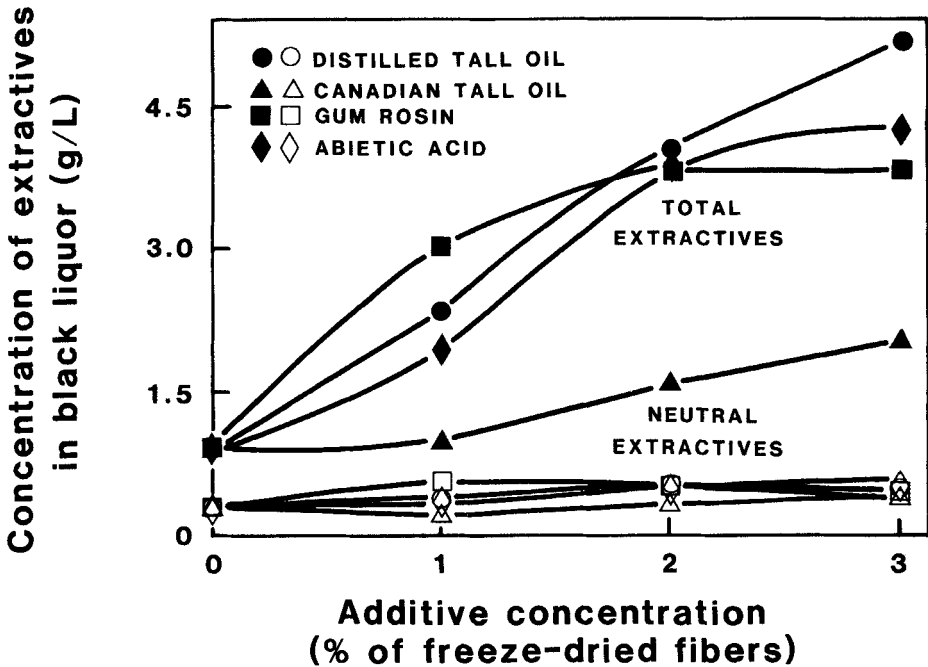
Figure 2:   Concentration of total extractives (shaded symbols) and
            neutral extractives (open symbols) in black liquor
            plotted against additive concentration.

This gives an indication of the quantities of neutral resin that
were detached from the fibers under the hot, non-equilibrium condi-
tions that exist in a digester; in other words, a measurement was
made of all the dispersed neutrals, whether emulsified, as mixed
liquid crystals, or solubilized.   It has been shown[19] that in
pure fatty acid (oleate) and fatty acid/resin acid (oleate/abietate)
mixtures, the solubilities of these materials decrease markedly as
the electrolyte concentration is increased.   Certainly, in the
digester the electrolyte concentration is high and one would expect
that, at equilibrium, both the wood resin and the added resin would
be dispersed as mixed liquid crystals[19].   However, the system is

not at equilibrium, and data are not presently available for the phase behavior of mixed wood resin materials at high temperatures. Also, there are many other naturally-occurring materials in the black liquor (e.g., lignin, hemicellulose) that must have an influence on the partition of the wood resin between the fibers and surrounding liquid. Nevertheless, from Figure 2 it is evident that the addition of various amphiphilic additives does have an effect on the partition of the neutrals between the liquid and the fibers, which has implications for tall oil recovery, deresination and pitch control. Canadian tall oil had the least influence, giving a small increase in the concentration of dissolved and dispersed neutrals, which increased with increasing Canadian tall oil charge; however, it must be remembered that the Canadian tall oil contained 25.1% neutral resin which itself would produce a small increase in the black liquor neutrals concentration, provided all the neutrals were not adsorbed onto the pulp fibers. The DTO was more effective than the Canadian tall oil.

The addition of resin acids, in the forms of pure abietic acid and gum rosin, also gave increases in the black liquor neutrals concentration. At the 1% addition level, the gum rosin was particularly effective, giving a 47% increase in the liquor neutrals content compared with the DTO. If this is significant and not just experimental error, there may be a link between this behavior and the fundamental findings of Palonen et al.[19] and Odberg et al.[20], which have shown that mixtures of fatty and resin acids can give a marked increase in the solubilization of neutral substances. Fatty acids are present in the wood of aspen, but resin acids are virtually absent[14] and, therefore, the addition of the latter could improve solubilization. The question remains as to why the pure form of the resin acids, abietic acid, did not give the same effect.

(3) Removal of Resin During Washing.

To get an idea of the effectiveness of these additives in the removal of the wood resin during pulp washing, the filtrates from

TABLE 3

Total Extractives and Neutral Extractives Contents of the Black
Liquors and First Wash Filtrates.

Additive	Charge (% on OD Fiber)	Extractives in Black Liquor		Extractives in Filtrate from First Wash	
		Total (g/L)	Neutrals (g/L)	Total (g/L)	Neutrals (g/L)
None	0	0.92	0.15	0.52	0.14
DTO	1.0	2.33	0.39	1.01	0.21
DTO	2.0	4.03	0.54	1.41	0.21
DTO	3.0	5.18	0.51	1.87	0.24
CTO	1.0	0.97	0.21	0.99	0.24
CTO	2.0	1.59	0.31	1.32	0.31
CTO	3.0	2.03	0.40	1.80	0.38
Gum Rosin	1.0	2.99	0.56	0.82	0.18
Gum Rosin	2.0	3.79	0.50	1.12	0.21
Gum Rosin	3.0	3.83	0.46	1.36	0.26
Abietic Acid	1.0	1.95	0.30	0.83	0.18
Abietic Acid	2.0	3.85	0.51	1.12	0.22
Abietic Acid	3.0	4.24	0.52	1.23	0.22

the first wash were analyzed for their neutrals content (Table 3).
The differences found in the neutrals content of the black liquor
were not as marked in the first wash filtrate. Except for the Can-
adian tall oil, all filtrates had similar neutrals contents, which
ranged from 0.21 to 0.26 g/L. The Canadian tall oil filtrates had
higher neutrals contents, which is probably a result of the initial
poor removal into the black liquor and the contribution of neutrals
from the Canadian tall oil.

The neutrals content of the unbleached pulp after multistage
washing (Figure 3) gives an idea of the potential for using these
additives to produce a pulp with low neutrals resin content. A
large amount of resin entering the bleaching sequence is detrimen-
tal, as chlorinated resins are particularly hydrophobic, and are
therefore more difficult to remove from the pulp[29] and tend to
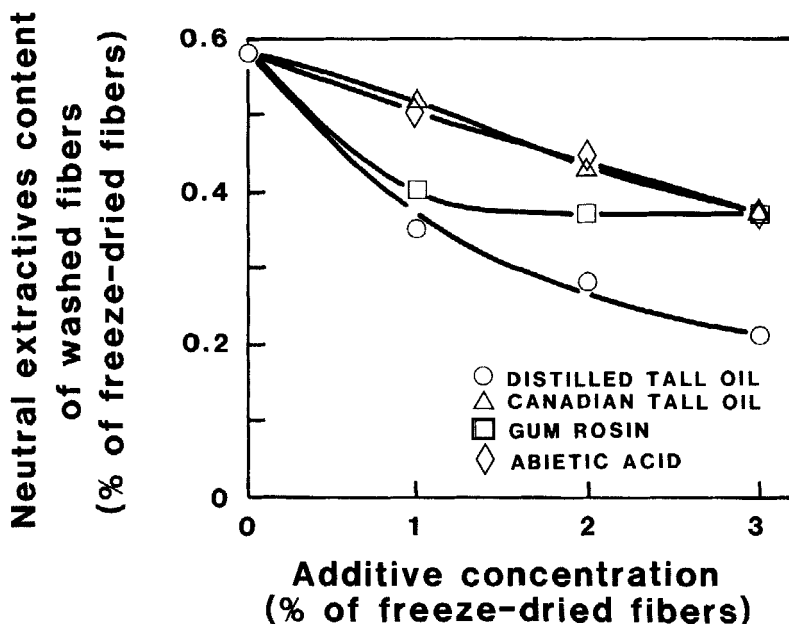contribute to pitch deposition. Again, a difference in the effec-

Figure 3: The amount of neutral extractives on the washed fibers versus additive concentration.

tiveness of the tall oils was found; at a 1% addition level, the DTO removed 50% more neutral resin than the Canadian tall oil. Another way of looking at this is that about 3% Canadian tall oil would have to be used to achieve the same effect as 1% DTO.

The addition of resin acids, in the form of pure abietic acid and gum rosin, showed, at low addition levels, that the gum rosin was a more effective deresinator; but neither was as effective as the DTO.

From the results in Table 3 it can be shown that, for all the additives used, the concentrations of black liquor extractives are lower than those calculated by assuming that 100% of additive is released into the liquor. It appears, then, that a substantial portion of additive remains associated with the fibers and may only be liberated during washing.

TABLE 4

The Effect of Adding to the Digester a Synthetic Surfactant, Alone and Mixed with Distilled Tall Oil, on the Removal of Neutral Resin during Kraft Pulping and Washing.

Charge of Synthetic Surfactant (% on OD fiber)	Charge of Distilled Tall Oil (% on OD Fiber)	Neutral Extractives Concentration		Total Acetone Extractives Content of Washed Fibers (% on Freeze-Dried Fiber)
		in Black Liquor (g/L)	in Washed Fibers (% on Freeze-Dried Fiber)	
0	0	0.36	0.68	–
0.05	0	0.37	0.61	0.75
0.1	0	0.36	0.65	0.73
0.5	0	0.30	0.61	0.69
0.01	0.5	0.36	0.52	–
0.05	0.5	0.35	0.52	0.59
0.1	1.0	0.45	0.36	0.52
0	1.0	0.39	0.49	0.40

Effects of a Synthetic Additive on Deresination

A commercial synthetic surfactant formulation that is current-
ly used in North America as a digester or brownstock deresination
aid was tested up to uneconomical charges of 0.5%. The surfactant
is also used in combination with tall oil as a means of reducing
tall oil consumption; therefore, mixtures of the two additives were
tested, and the results are shown in Table 4. When the surfactant
formulation was used alone, it appeared to offer little improvement
in pulp deresination, either in the digester or during pulp washing.
However, when tall oil was added as well as the surfactant, deresin-
ation increased. The question is whether it was the tall oil alone
that increased deresination, or whether there was some synergy in
mixing the two additives. Comparing these data with those shown in
Figure 3, it appears that the synthetic surfactant offers little
advantage. Although, in the self-contained data shown in Table 4,
1% tall oil was shown to reduce the washed fiber neutrals from 0.68
to 0.49% and the simultaneous addition of a highly uneconomical
charge of 0.1% surfactant reduced the fiber neutrals to 0.36% –
essentially, even an overdose of surfactant plus tall oil failed to
show promise.

TABLE 5

Washing of Pulps (Earlier Work).

	Volume of Fresh Water Added (L)	Volume of Filtrate (L)
First Wash	26.0	12.7
Second Wash	12.7	13.7
Third Wash	13.7	12.7

EARLIER WORK

Experiments were conducted on a seasoned aspen sample. The wood had been shipped shortly after felling, and was stored in a coldroom at 5°C for approximately 6 months. The chips were screen-ed before pulping. Kraft pulps were prepared in a 20-litre diges-ter, with a charge of 2 kg O.D. wood. Cooking conditions, yields, and kappa number were similar to those described in the "Methods" section.

The following additives were used:
. Canadian tall oil, acid no.: 125
. Southern USA tall oil, acid no.: 161
. Rosin size (dark paste size no. 722 from Hercules), containing approximately 10% neutrals.

Various concentrations of each additive were well mixed with the cooking liquor and then poured into the digester, as described previously.

At the end of each cook, the spent liquor was drained from the pulp. A fixed volume (26 litres) of fresh water was added to the pulp, which was then stirred vigorously and filtered through a 200-mesh screen. A measured amount of filtrate was collected and an equal volume of fresh water was added to the pulp. This

procedure was repeated to provide a total of three washings. Vol-
umes of fresh water added to the pulps and filtrates collected are
given in Table 5.

A separate portion of each pulp from the third wash was
diluted with fresh water and made into handsheets using a British
Sheet machine.

Samples of freeze-dried pulps after the third wash and of
freeze-dried handsheets were Soxhlet-extracted with acetone as
described previously.

Figure 4 shows the percentage acetone extractives as a func-
tion of additives concentration for pulps after the third wash
(upper set of curves, filled symbols) and for handsheets (lower set
of curves, open symbols). It should be noted that for each curve
with a given additive, a cook without additives was made to provide
a blank. As indicated by the different intercepts at zero addition
level in Figure 4, there were some minor differences in percent
extractives of the blank pulp samples.

Pulps after third wash:

By far, the most significant effect was observed with the
Southern USA tall oil. The concentration of extracts decreased from
an initial value of 0.91% without additives to 0.59% at a 2.5%
addition level, corresponding to a reduction of 35%. At the same
addition level, the rosin size and the Canadian tall oil produced a
reduction of 14 and 5%, respectively.

Handsheets:

The extractives content of handsheets from all cooks were
considerably lower than those from the pulp after the third wash.
Again, the reduction in percent extractives was highest with the
Southern USA tall oil. However, in contrast to the results in the
upper set of curves, the Canadian tall oil produced an appreciable
decrease in extractives content, whereas the rosin size had very
little effect.

The results in Figure 4 also suggest that the effectiveness of
the Canadian tall oil may be influenced by the extent of pulp wash-
ing. Pulp samples after the third wash showed practically no change
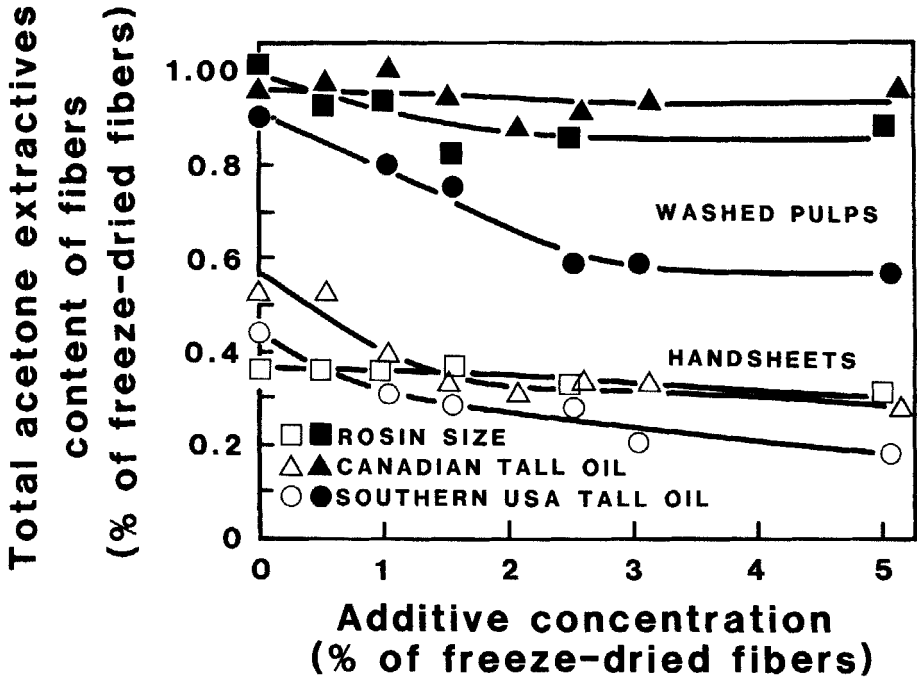
Figure 4: In earlier work, although somewhat different additives
           and experimental conditions were used, similar results
           to those in Figure 1 were obtained. The total acetone
           extractives content of the fibers is plotted against
           additive concentration for pulp washed under conditions
           carefully chosen to duplicate pulp mill conditions
           (shaded symbols) and for handsheets (open symbols).
           Because of the fresh water dilution required for the
           preparation of the handsheets, they constituted a much
           better washed pulp, and this is evident from the
           considerably lower levels of extractives.

in extractives content with increasing tall oil concentrations.
However, with the more extensively washed handsheets, there was a
pronounced decrease in extractives content.   A similar reduction in
percent extracts was also observed in Figure 1 with the Canadian
tall oil.   For both the results in Figure 1 and those for handsheets
(Figure 4), the pulps were washed more extensively than the pulp

after the third wash. The washing procedure used for the upper set
of curves in Figure 4 was chosen so that the lignin and soap concen-
trations in the filtrate corresponded approximately to those usually
found in brownstock screenroom white waters of mills.

These results suggest that, under normal conditions of brown-
stock washing, addition (to the digester) of a tall oil with low
acid number may not be very effective at improving the deresination
of aspen. It may then only be possible to achieve a significant
reduction in resin content by either using a tall oil with relative-
ly high acid number, possibly above 140, or by considerably increas-
ing the efficiency of washing, which may not be a practical
alternative.

Wood seasoning does not appear to be an important factor in
determining the effectiveness of additives, since essentially the
same conclusions were obtained using fresh or seasoned aspen wood.

It should be emphasized that the overall benefits of using a
given additive will have to be assessed for each particular
situation.   Since   several   factors   influence   the   extent   of
deresination, such as wood used, type and amount of additive,
washing efficiency, it is recommended that a mill trial be
conducted first to establish optimum conditions and to determine if
such an additive program is economically viable.

SUMMARY

1. Half of the potentially saponifiable aspen wood resin, as
    determined by a standard laboratory saponification procedure,
    was not saponified under typical kraft mill cooking conditions.
2. Storage of aspen chips in a freezer at -20°C appears to affect
    the degree to which wood resin is removed during kraft cooking.
3. Additives improved the deresination of fresh and seasoned aspen
    after a kraft cook and multi-stage laboratory washing.   The
    relative effectiveness of the additives was as follows:
    DTO > Canadian tall oil > Gum Rosin > Abietic Acid.

4. The addition of tall oil with a high acid number can significant ly decrease (e.g., by 30-50%) the amount of resin in aspen kraftt pulp.

5. Canadian tall oils, with lower acid numbers, were less effective; for example, in several experiments it required a 3% charge of Canadian tall oil to obtain the same level of deresination that a Southern USA tall oil could achieve at a 1% charge.

6. The removal of neutrals from the fibers into the black liquor was increased with additives.

7. After pulping and washing in the presence of additives, the neutral resin content of the fibers was lowered and the relative effectiveness of the additives for the removal of neutrals was as follows:
   DTO > Canadian tall oil> Gum Rosin> Abietic Acid.

8. A commercial surfactant formulation did not improve deresination sufficiently to be considered as a replacement for tall oil or as an additive to reduce tall oil consumption.

ACKNOWLEDGMENTS

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