

# EXPERIMENTS IN THE MANUFACTURE OF NEWSPRINT FROM COTTONWOOD AND WILLOW

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EXPERIMENTS IN THE MANUFACTURE OF NEWSPRINT

FROM COTTONWOOD AND WILLOW

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Summary and Conclusions

Newsprint was made using cottonwood and willow pulps blended in most cases with southern pine semibleached sulfate pulp. The cottonwood was converted to pulp by the groundwood, chemigroundwood, neutral sulfite semichemical, and cold soda processes. Each yielded pulps of good color, strength, and quality. A newsprint paper with average strength and opacity was made from a mixture of 90 percent cottonwood groundwood and 10 percent southern pine kraft. The chemigroundwood, neutral sulfite semichemical, or cold soda cottonwood pulps, when used as 30 percent of the furnish, gave papers high in strength, high in brightness, but slightly low in opacity.

The furnish used in the basic series of paper machine runs consisted of 60 percent cottonwood groundwood, 10 percent semibleached pine kraft, and 30 percent of either chemigroundwood, semichemical, or cold soda cottonwood pulp. These papers had bursting strengths equal to or higher than commercial newsprint. The tearing strength in each case was at least 50 percent higher than the average of commercial papers. The opacity of these papers was slightly low -- 85 to 88 as compared to a minimum of 88 percent ordinarily considered acceptable. The brightness of these papers was excellent, 64 to 67 percent compared to 58 percent for commercial newsprint.

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<sup>1</sup>Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

The addition of clay to these papers raised the opacity from 2 to 3 points. The clay also caused a loss of strength, although the bursting and tearing strength values were still about equal to or above those of the commercial papers.

Papers made from 100 percent of hardwood were adequate in bursting strength. They were considerably lower in tearing strength than those containing softwood, but still about equal to commercial papers. These papers were composed of 75 percent cottonwood groundwood and 25 percent cottonwood chemigroundwood, neutral sulfite semichemical, or cold soda pulps.

Willow groundwood, although darker and much weaker than the cottonwood groundwood, gave paper of good strength and sufficiently high in brightness when used to the extent of 30 percent of the furnish.

These results indicate that newsprint can be manufactured from a blend of cottonwood groundwood and semibleached softwood sulfate pulp in the proportions that groundwood and chemical pulp are normally used. Semichemical, chemigroundwood, and cold soda pulps made from cottonwood can be used either to compensate for lack of strength in cottonwood groundwood or to replace part of the semibleached pine sulfate pulp in the blend.

There was no evidence of machine operating difficulties that would preclude high-speed operation. On the other hand, it is common experience that a certain amount of long fiber is essential for conventional high-speed operation. The amount needed, if any, can only be determined by mill-scale trials.

### Introduction

The work described in this report was done at the request of the United States Department of Commerce as a part of an extensive inquiry into the possibilities of broadening the base of raw materials used by the domestic newsprint industry. The inquiry began in 1952 at the request of Congress

for a study of factors concerning the expansion of newsprint production in the United States.<sup>2, 3, 4</sup>

Work at the Forest Products Laboratory has demonstrated that hardwoods can be used in the manufacture of newsprint.<sup>5</sup> This work has shown that substantial amounts of groundwood pulps prepared from low-density, light-colored hardwoods, such as aspen or poplar, can be used. Many hardwoods, however, produce groundwood pulps much lower in strength and darker in color, which limits their use to a much smaller proportion of the total fiber composition.

The Laboratory has also demonstrated that the low strength of groundwood pulps from many hardwood species can be compensated for by blending them with hardwood pulps made by any one of three other processes: semichemical, chemigroundwood, and cold soda. These pulps might also be used as substitutes for at least a part of the long-fiber softwood component; that is, either for unbleached sulfite or semibleached sulfate pulps that are ordinarily used in mixtures with groundwood for newsprint.

Semichemical pulp is produced by softening wood chips with chemical solutions and only partly dissolving certain of the wood constituents. The chemical solutions used may vary. The one used in this investigation was a neutral sodium sulfite solution. The treatment is made at relatively low temperature and pressure compared to the sulfite, soda, and sulfate processes. The softened chips are then reduced to pulp fibers in an attrition mill. The yield of pulp is relatively high, from 65 to 80 percent of the wood.

Cold soda pulp differs from semichemical pulp in that the chemical treatment consists of treating the chips with caustic soda solution at room

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<sup>2</sup>Study of Newsprint Expansion, A Progress Report of the Department of Commerce to Subcommittee No. 5 of the Committee on the Judiciary, House of Representatives, Washington. 1952.

<sup>3</sup>Study of Newsprint Expansion: Part II. Newsprint Production from Hardwoods. Second Progress Report of the Department of Commerce to the Committee on the Judiciary, House of Representatives. 1954.

<sup>4</sup>For obtaining suitable wood for the work, acknowledgment is made to the Delta Research Center of the U. S. Forest Service, the Delta Branch of the Mississippi Agricultural Experiment Station, and the Delta Pine and Land Company.

<sup>5</sup>Use of Hardwoods in the Manufacture of Newsprint, by G. H. Chidester, Forest Products Laboratory Report No. 2027.

temperature. The softening action is largely caused by swelling of the wood structure. As in semichemical pulping, the treated chips are processed in an attrition mill. The yield is from 85 to 90 percent of the weight of wood.

Chemigroundwood pulp differs from groundwood pulp in that the bolts of wood are given a mild chemical treatment before they are ground. Chemigroundwood pulp is usually stronger and is usually produced with less energy than groundwood made from the same wood. The yield is from 85 to 90 percent of the wood.

In the experiments reported here, newsprint was made from (a) mixtures of cottonwood groundwood and semibleached pine sulfate; and (b) mixtures of cottonwood groundwood and semibleached pine sulfate with cottonwood semichemical, chemigroundwood, or cold soda pulps. The special pulps were added to compensate for any weakness in the cottonwood groundwood or as substitutes for a part of the long-fiber (pine) component. The experiments were designed so that the results obtained from the use of the special pulps could be directly compared. One purpose of the experiment was to find alternative processes for using hardwoods that might be advantageous for different conditions.

The basic series of papers consisted of 60 percent of cottonwood groundwood pulp, 10 percent of commercial semibleached southern pine sulfate pulp, and 30 percent of cottonwood pulp prepared by either the chemigroundwood, the neutral sulfite semichemical, or the cold soda process. Variations in this basic formula were made in subsequent experiments.

Because only single runs were made in producing most of the experimental pulps, the results do not necessarily represent the optimum. Some uncontrolled variation from one paper machine run to another was inevitable. Therefore, the technical data reported here should not be considered final, but simply indicative of possibilities.

#### Groundwood and Chemigroundwood Pulping

The logs used for these pulping experiments were taken at random from shipments of cottonwood and willow and cleaned of all bark and other material that might contribute dirt to the pulp. Disks for physical tests were cut from each log used. Data on the physical characteristics of the wood used for groundwood are given in table 1.

The experimental grinder used in this work was a three-pocket type equipped with a sandstone 5 $\frac{1}{4}$  inches in diameter and 8 inches wide. Data on grinding

conditions and operating data for the various experiments are given in table 2.

Logs for chemigroundwood (CGW) were cooked in a horizontal jacketed cylinder of 20-cubic-foot capacity. The logs (in 4-foot lengths) were treated as follows: (1) vacuum of 25 inches for 1/2 hour, then liquor drawn in; (2) indirect steam on jacket for 1/2 hour; and (3) air pressure applied on top of the liquid in the cylinder to raise the total pressure to 150 pounds per square inch and proper steam pressure maintained on the jacket for a total of 5.5 hours. Additional information on treating conditions, as well as on grinding data for the chemigroundwood pulps, are given in table 2.

### Discussion of Grinding Results

The cottonwood groundwood (grinder run No. 1010) was of fairly good quality. It was comparable in strength and freeness to a cottonwood groundwood prepared previously.<sup>6</sup> The brightness was very good; it was considerably higher than that obtained on the previous experiment and equal to that of spruce and aspen groundwood pulps prepared at the Laboratory. The energy consumption was high, about 50 percent higher than that found in the earlier study. Under the limitations of time for this study, it was not possible to investigate thoroughly the minimum energy requirements for producing a suitable groundwood; it is believed that wood of this type could be converted to a suitable pulp with only a moderate increase in energy over that needed for conventional newsprint groundwood. The yield of groundwood was estimated to be normal for the process, 92 to 95 percent by weight.

The willow groundwood prepared in grinder run No. 1013 was much lower in strength and brightness than the cottonwood groundwood. However, according to limited data obtained some years ago at the Laboratory on the grinding of willow,<sup>6</sup> pulps comparable in strength to cottonwood groundwood (grinder run No. 1010) can be made from willow.

The cottonwood chemigroundwood (CGW) pulps prepared in grinder run Nos. 1011 and 1014 were both higher in strength and freeness but lower in brightness than the groundwood (grinder run No. 1010). Their strength values and freeness were, however, lower than that of the neutral sulfite semichemical (NSSC) pulps, as shown in table 3. The wood used for CGW No. 1011 was believed to be too mildly treated to produce a strong pulp. Therefore, a

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<sup>6</sup>Forest Products Laboratory Report R1419. Paper Trade Jour. 116(4):25-32. (January 28, 1943).

second batch of logs was treated, using a slightly higher solution concentration and temperature. The pulp obtained from this run (CGW No. 1014) was higher in strength and freeness than that from CGW No. 1011 and consumed about half as much energy. The CGW pulps were lower in brightness than the groundwood pulps, and the increase in the severity of the treatment caused an additional lowering in the brightness. The yield of CGW No. 1014 is estimated to be between 85 and 90 percent.

## Semichemical and Cold Soda Pulping

### Wood Preparation

The bark was removed from the cottonwood pulpwood before the logs were reduced to standard 5/8-inch pulping chips in a 47-inch chipper. Undersized and oversized material was removed from the chips by screening. The chips were green and had a moisture content of approximately 53 percent.

### Semichemical Pulping

The neutral sulfite process, employing sodium sulfite as the pulping agent and sodium bicarbonate as the buffering agent, was used to make the semichemical pulp. The chips were digested in a tumbling, cylindrical digester lined with stainless steel that had a capacity of 13 cubic feet. Presteamming was used to aid penetration. The cooking liquor was made up from commercial-grade chemicals. The conditions for the digestion are given in table 4.

The amount of sodium sulfite used for the pulping was 15 percent. The yield of pulp was 79.5 percent of the moisture-free wood charged to the digester (table 4). The basic chemical requirements for making a ton of air-dry pulp were thus 86 pounds of sulfur and 370 pounds of soda ash (sodium carbonate).

After they were digested and washed, the chips were fiberized in a double-disk refiner in a one-pass operation. The freeness of the pulp was 585 milliliters (Canadian Standard), and the energy requirement was 24.8 horsepower-days per ton of air-dry pulp.

In comparison with many other hardwoods used for semichemical pulping, including other samples of cottonwood, the cottonwood in this experiment had relatively high chemical and fiberizing energy requirements.

## Cold Soda Pulping

The cold soda process consists of steeping the chips in a solution of sodium hydroxide at room conditions. A tumbling, cylindrical digester of 14 cubic feet capacity was used for the steeping. The conditions are given in table 5.

The chemical consumed during the steeping amounted to 5.52 percent and the yield of fiberized pulp was 91.3 percent, both on the basis of the moisture-free wood (table 5). The chemical consumption on the basis of an air-dry ton of pulp was 109 pounds.

The treated chips were drained free of liquor and washed with water before being fiberized in a 36-inch, double-disk mill. The fiberizing conditions are given in table 6. The fiberizing was done in one stage except that about one-fourth of the pulp was recycled through the mill in the course of the operation. The pulp thus produced had a freeness of 460 milliliters and the fiberizing operation required an energy consumption of 42.7 horsepower-days per ton of air-dry pulp (table 6). A fiberizer of higher power could probably fiberize the material in one pass with a lower energy consumption.

The results showed that the treatment was relatively mild in its effect on the cottonwood. This was evidenced by the low chemical consumption, the high yield of pulp, and the very high energy required for fiberizing. This pulp had properties between those of a softwood groundwood pulp and a well-pulped semichemical pulp.

## Papermaking Experiments

### Operating Conditions

Pulps were thoroughly blended in a 50-pound beater and made into papers on a 13-inch experimental paper machine. The southern pine semibleached sulfate pulp was beaten separately from a freeness of 750 to 530 milliliters (Canadian Standard) to develop a better bonding strength. Enough sulfate pulp for all runs was prepared in this manner and wet-lapped to provide a uniform source of the long-fibered pulp.

Each kind of pulp was sampled as it was lapped on the wet machine, and tested for freeness and strength. The results, which are given in table 3, provide a comparison of the pulps at a point in processing immediately preceding their blending for papermaking.



The components selected for each run were then mixed at a consistence of about 3-1/2 percent. The pH value was adjusted to about 6.0 with sulfuric acid and further to 5.0 with alum. The stock was dropped to the chest and diluted to 2 percent consistence with water similarly adjusted for pH. A pH value of 5.0 was held in the paper machine water system by adding alum. These conditions were constant for all runs. No sizing was used in any of the runs, but in four runs 5 percent of clay was added to the beater stock.

Machine conditions were held as constant as possible for all runs to permit the best comparison of the various pulp furnishes. These papers were run to approximately the same basis weight, permitting a variation in thickness. The machine was run at a speed of 75 feet per minute.

The consistency of the stock in the machine headbox was constant at about 0.5 percent, and stock from the chest was diluted with white water. Samples of the stock for freeness tests were taken from the machine chest to show the effects of the addition of the various pulps on the freeness of the blends. Samples were also taken from the machine headbox to determine the effects of recirculation of fines on freeness of the stock at the machine. Suction boxes were used, and the water they extracted was discarded. A dandy roll was also used. The sheets passed through three wet presses, which were loaded only moderately. Most sheets were passed through three nips of the calender stack. Although this was insufficient calendering in some cases, this degree of calendering was used to provide a better comparison of the primary variables in the series. However, in three runs a full calender stack with high pressure was used to provide a smoother surface.

#### Discussion of Papermaking Experiments

The pulp furnish, freeness at chest and headbox, and properties of the sheets are given in table 7. No operating difficulties were evident in running the pulps. No difference in drainage was noted in sheets containing chemigroundwood, neutral sulfite semichemical, or cold soda pulps as 30 percent of the furnish. In general all of these drained more readily than sheets that were higher in groundwood content and probably more readily than conventional newsprint stock. Although strength of the wet web and adhesion to the press rolls did not present an operating problem for these runs, the sheets containing 100 percent hardwood tended to stick to the first wet press more than those with a portion of the long-fiber (pine) kraft. There was no evidence of difficulties that would preclude high-speed operation. On the other hand, it is common experience that a certain amount of long fiber is essential for conventional high-speed operation. The amount needed, if any, can only be determined by

mill-scale trials. The formation of the papers was more uniform than is observed in ordinary newsprint paper.

The basic series of papers consisted of 60 percent cottonwood groundwood, 10 percent of the long-fibered (pine) kraft, and 30 percent of cottonwood chemigroundwood (machine run 4244), cold soda (machine run 4236), or neutral sulfite semichemical (machine run 4237). These furnishes contained 90 percent of hardwood fiber.

The bursting strength in points was 12.2 for the paper containing neutral sulfite semichemical, 11.3 for cold soda, and 9.7 for chemigroundwood. These compare with an average bursting strength of 9.5 points obtained in tests of a large number of commercial newsprint papers. The tearing strength of these experimental papers was at least 50 percent higher than the average obtained in the commercial papers.

The opacity of these three experimental papers ranged from 85.5 to 87.3 percent, which is slightly lower than the 88 percent considered as a minimum for newsprint paper. In another run (machine run 4238) containing 90 percent of cottonwood groundwood, and none of the "special" pulps, the opacity was only 88.9 percent; this indicates that the difference between the average commercial news (see table 7) and the experimental sheets was not due entirely to the "special" pulps, but was partly due to the groundwood. It is possible that the opacity would be slightly improved for equivalent papers made on a commercial machine.

The brightness of these papers, which was 66.4 percent for the one containing chemigroundwood, 67.5 percent for the neutral sulfite semichemical, and 64.2 percent for the cold soda, were all considerably higher than the 58 percent obtained on commercial newsprints.

To sum up the effects of the chemigroundwood, semichemical, or cold soda pulps when used as 30 percent of the furnish, the resultant papers were high in strength, high in brightness, but slightly low in opacity.

The addition of 5 percent clay to the furnish resulted in a 2 to 3 percentage point increase in opacity. This was achieved with some loss of strength, of course, although the bursting and tearing strengths were still about equal to or above that of the commercial papers.

Although it is customary to tint commercial newsprint, no color was added in the basic series of papers in order to permit a comparison of the special pulps. However, the cold soda pulp has a characteristically yellow tint, and to overcome this a methyl violet toner was added in two of the papers (machine runs 4239 and 4243). It was also observed that some of the yellow tint of the cold soda pulp disappeared when the pH was adjusted to the proper level for running on the paper machine.

The furnish for the runs containing 100 percent hardwood pulps consisted of 75 percent of the cottonwood groundwood and 25 percent of cottonwood chemigroundwood (machine run 4250), cottonwood neutral sulfite semichemical (machine run 4242), or cottonwood cold soda (machine run 4243). These papers are considerably lower in tearing strength than those of the original series, but they were still about equal to that of the commercial papers. The bursting strength for the paper containing neutral sulfite semichemical pulp was equal to that of commercial newsprint paper, but the other two papers had values about 12 to 16 percent lower. The opacity of these papers was better than that of the basic series, probably because of the increased groundwood content.

Two runs were made in which 30 percent willow groundwood was used. In spite of the fact that this groundwood was somewhat lower in brightness and much weaker, the papers containing it were good in strength and sufficiently high in brightness. A detailed comparison can be made between runs 4237 and 4245 in table 7.

Table 1.--Average physical characteristics of the cottonwood and willow used in pulping and papermaking experiments

| Species and process                                 | Number of logs | Diameter <sup>1</sup><br>Inches | Age of logs<br>Years | Rate of growth<br>Rings per inch | Specific gravity <sup>2</sup> | Amount of dark wood, <sup>3</sup><br>Percent by volume |
|---|----------------|---------------------------------|----------------------|----------------------------------|-------------------------------|--|
| <u>Cottonwood</u>                                   |                |                                 |                      |                                  |                               |  |
| Chips (neutral sulfite semi-chemical and cold soda) | 13             | 7.2                             | 18.7                 | 5.1                              | 0.400                         | 38.0   |
| Groundwood  | 29             | 6.8                             | 15.7                 | 4.8                              | .397                          | 40.0   |
| Chemigroundwood                                     | 24             | 6.4                             | 16.2                 | 5.0                              | .390                          | 25.3   |
| Average   | 66             | 6.8                             | 16.5                 | 4.9                              | .395                          | 34.2   |
| <u>Willow</u>                                       |                |                                 |                      |                                  |                               |  |
| Groundwood  | 4              | 6.9                             | 7.3                  | 2.1                              | .431                          | 11.5   |

<sup>1</sup>Peeled disk.

<sup>2</sup>Based on oven-dry weight and green volume.

<sup>3</sup>Dark wood consisted of heartwood, both normal and pathological.

Table 2.--Data on groundwood and chemigroundwood  
pulping of cottonwood and willow

| Item  | Cottonwood      |             | Willow      |             |
|---|-----------------|-------------|-------------|-------------|
|   | Chemigroundwood | Ground-wood | Ground-wood | Ground-wood |
| Grinder run No. . . . .   | 1011            | 1014        | 1010        | 1013        |
| Treatment of logs: <sup>1</sup>                                       |                 |             |             |             |
| Temperature . . . . . °C.   | 140             | 150         |             |             |
| Liquor concentration. . lb. per gal.                                  | .95             | 1.05        |             |             |
| Grinding data: <sup>2</sup>   |                 |             |             |             |
| Pressure of wood on stone . .p.s.i.                                   | 15              | 25          | 35          | 40          |
| Grinder pit temperature . . . . °F.                                   | 130             | 130         | 160         | 160         |
| Grinding rate, per sq. ft.<br>per 24 hrs. . . . . tons <sup>3</sup>   | .47             | 1.45        | .83         | 1.05        |
| Energy consumption, per<br>ton <sup>2</sup> of wood . . . . .hp.-days | 92              | 45          | 105         | 110         |

<sup>1</sup>Other conditions of cooking common to both were: time, 5.5 hours; pressure, 150 pounds per square inch; initial vacuum phase, 0.5 hour; length of logs, 4 feet; moisture content of wood, 55 percent (based on wood plus moisture); and liquor composition, ratio of sodium sulfite to sodium bicarbonate was 6 to 1 expressed as sodium carbonate.

<sup>2</sup>Other conditions of grinding common to all the grinder experiments were: peripheral speed, 3,120 feet per minute; consistency in grinder pit, 3 to 4 percent; pulpstone, dull-surfaced sandstone with 10-cut, 1-1/2-inch lead spiral burr pattern.

<sup>3</sup>Tons refers to moisture-free wood ground.

Table 3.--Results of tests on pulps<sup>1</sup> used in newsprint experiments

| Kind of pulp <sup>1</sup>   | Freeness<br>(Canadian<br>Standard) | Ream<br>weight<br>(25 x<br>40 -<br>500) | Thick-<br>ness | Den-<br>sity       | Burst              | Tear               | Tensile:<br>Bright-<br>ness<br>(G.E. On 24-<br>equiv-<br>lent) | Screen analysis; retained -- |                        |                        | Fiber<br>length<br>index |      |       |       |
|---|------------------------------------|---|----------------|--------------------|--------------------|--------------------|--|------------------------------|------------------------|------------------------|--------------------------|------|-------|-------|
|   |                                    |   |                |                    |                    |                    |  | 24-42<br>mesh                | 42-80<br>mesh          | 80-150<br>mesh         |                          |      |       |       |
| MI.   | Lb.                                | Mile                                    | cc.            | lb. per<br>sq. ft. | lb. per<br>sq. ft. | lb. per<br>sq. ft. | Percent<br>of<br>total   | Percent<br>of<br>total       | Percent<br>of<br>total | Percent<br>of<br>total |                          |      |       |       |
| Cottonwood groundwood<br>(G.R. 1010)                              | 105                                | 114.8                                   | 16.3           | 0.39               | 0.19               | 0.47               | 2,190  | 65.5                         | 1.10                   | 1.25                   | 41.00                    | 9.50 | 47.15 | 0.088 |
| Cottonwood chemigroundwood:<br>(G.R. 1011)                        | 360                                | 116.4                                   | 14.9           | .29                | .29                | .80                | 3,540  | 59.1                         | .40                    | 1.30                   | 69.00                    | 5.70 | 23.60 | .131  |
| Cottonwood chemigroundwood:<br>(G.R. 1014)                        | 485                                | 117.8                                   | 15.2           | .43                | .37                | .94                | 3,780  | 50.5                         | .85                    | 10.65                  | 69.95                    | 3.70 | 14.85 | .167  |
| Cottonwood cold soda<br>(Digestion 4118)                          | 500                                | 120.0                                   | 11.8           | .56                | .39                | 1.03               | 3,410  | 51.9                         | 1.80                   | 5.45                   | 63.55                    | 4.75 | 24.45 | .132  |
| Cottonwood neutral sulfite:<br>semichemical<br>(Digestion 5563 N) | 630                                | 114.8                                   | 10.2           | .62                | .63                | 1.40               | 5,080  | 54.6                         | .50                    | 7.30                   | 75.30                    | 3.65 | 13.25 | .172  |
| Southern pine semibleached:<br>sulfate (Shipment 4039)            | 530                                | 115.6                                   | 9.2            | .70                | 1.13               | 3.27               | 6,640  | 55.5                         |                        |                        |                          |      |       |       |
| Willow groundwood<br>(G. R. 1013)                                 | 75                                 | 120.8                                   | 20.2           | .33                | .11                | .29                | 1,373  | 49.8                         | .80                    | .85                    | 31.65                    | 8.50 | 58.20 | .076  |

<sup>1</sup>All pulps were made at the Forest Products Laboratory except the southern pine semibleached sulfate, which was a commercial pulp. The sulfate pulp was beaten to a freeness of 530 milliliters before use in the paper furnishes.

Table 4.--Conditions and results of cook-  
ing cottonwood by the neutral  
sulfite semichemical process

DIGESTION NO. 5563 N

Wood charged

|                            |           |       |
|----------------------------|-----------|-------|
| Wet weight . . . . .       | .lb.:     | 245.5 |
| Dry weight . . . . .       | .lb.:     | 115.9 |
| Moisture content . . . . . | .percent: | 52.8  |

Liquor charged

|                                    |             |      |
|------------------------------------|-------------|------|
| Volume . . . . .                   | gal.:       | 58.0 |
| Concentration:                     | :           |      |
| $\text{Na}_2\text{SO}_3$ . . . . . | gm. per l.: | 36.1 |
| $\text{NaHCO}_3$ . . . . .         | gm. per l.: | 14.1 |
|                                    | :           |      |
| Amount per 100 pounds of dry wood: | :           |      |
| $\text{Na}_2\text{SO}_3$ . . . . . | .lb.:       | 15.0 |
| $\text{NaHCO}_3$ . . . . .         | .lb.:       | 5.9  |

Temperature schedule

|   |         |      |
|---|---------|------|
| Presteam (0 p.s.i.) . . . . .           | .hr.:   | .5   |
| Cooking temperature . . . . .           | .°C.:   | 170  |
| Rise to 170° C. $\frac{1}{2}$ . . . . . | .hr.:   | 2.0  |
| Held at 170° C. $\frac{1}{2}$ . . . . . | .hr.:   | 1.25 |
| Pressure <sup>2</sup> . . . . .         | p.s.i.: | 150  |

Pulp yield . . . . . .percent: 79.5

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<sup>1</sup>Indirect steam.

<sup>2</sup>Digester not relieved.

Table 5.--Conditions and results of pulping cotton-  
wood by the cold soda process

TREATMENT NO. 4118

Wood charged

|                            |           |       |
|----------------------------|-----------|-------|
| Wet weight . . . . .       | .lb.:     | 270.0 |
| Dry weight . . . . .       | .lb.:     | 126.9 |
| Moisture content . . . . . | .percent: | 53.0  |

Sodium hydroxide liquor charged

|  |             |      |
|--|-------------|------|
| Volume . . . . .   | gal.:       | 64.0 |
| Concentration, as charged. . . . .                       | gm. per l.: | 57.2 |
| Concentration, in digester . . . . .                     | gm. per l.: | 45.2 |
| Amount per 100 pounds of<br>moisture-free wood . . . . . | :<br>.lb.:  | 24.0 |

Sodium hydroxide consumed

|  |            |      |
|--|------------|------|
| Amount per 100 pounds of<br>moisture-free wood charged . . . . . | :<br>.lb.: | 5.52 |
|--|------------|------|

Treating schedule

|                        |       |    |
|------------------------|-------|----|
| Steeping time. . . . . | .hr.: | 2  |
| Temperature. . . . .   | .°C.: | 30 |

|                             |           |      |
|-----------------------------|-----------|------|
| <u>Pulp yield</u> . . . . . | .percent: | 91.3 |
|-----------------------------|-----------|------|

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Table 6.--Conditions and results of fiberizing cottonwood cold  
soda and neutral sulfite semichemical pulps

| Bauer run No.   | Plate<br>clear-<br>ance | Feed<br>speed<br>setting | Ammeter<br>reading<br>(average) | Pulp<br>consist-<br>ency | Fiber-<br>izing<br>energy                            | Pulp free-<br>ness<br>(Canadian<br>Standard) |
|---|-------------------------|--------------------------|---------------------------------|--------------------------|--|--|
|   | <u>In.</u>              |                          | <u>Amps</u>                     | <u>Percent</u>           | <u>Hp.-days</u><br><u>per air-</u><br><u>dry ton</u> | <u>ML.</u>                                   |
| 1002<br>(Neutral sulfite<br>semichemical,<br>Digestion<br>No. 5563 N) | 0.007                   | 3                        | 300                             | 9                        | 24.8   | 585  |
| 1001<br>(Cold soda,<br>Digestion<br>No. 4118)                         | .007                    | 1                        | 300                             | 9                        | 42.7   | 460  |

<sup>1</sup>About one-fourth of this pulp was recycled during fiberizing, which partly accounts for the relatively high energy consumption. Recycling this amount was necessary to obtain pulp with the desired freeness. A higher power fiberizer could probably fiberize the material in one pass with a lower energy consumption.

Table 7.--Test results on newsprint papers made from unbleached hardwood pulp

| Machine<br>run No.   | Furnish | Amount  | Other pulps                 |                 | Freeness<br>(Canadian<br>Standard) | Basic weight<br>#/lb. x 24 | Thickness<br>#/36" | Density | Bursting<br>strength | Properties                      |                              |                      |                     |                 |                |                |                |     |    |      |
|--|---------|---------|-----------------------------|-----------------|------------------------------------|----------------------------|--------------------|---------|----------------------|---------------------------------|------------------------------|----------------------|---------------------|-----------------|----------------|----------------|----------------|-----|----|------|
|  |         |         | Kind                        | Kind            |                                    |                            |                    |         |                      | Average tear-<br>ing resistance | Average fold-<br>ing tensile | Average opac-<br>ity | Air resist-<br>ance | Bright-<br>ness | Ash            |                |                |     |    |      |
|  |         |         | wood<br>ground-<br>bleached | wood<br>sulfite |                                    | 25 x<br>40 -<br>500        |                    |         |                      | endur-<br>ance                  | endur-<br>ance               | endur-<br>ance       | endur-<br>ance      | endur-<br>ance  | endur-<br>ance | endur-<br>ance | endur-<br>ance |     |    |      |
| Percent  | Percent | Percent | Percent                     | Percent         | MI.                                | MI.                        | MI.                | MI.     | MI.                  | MI.                             | MI.                          | MI.                  | MI.                 | MI.             | MI.            | MI.            | MI.            | MI. |    |      |
| Average of commercial newsprint papers..... 36.0 : 32.8 : 3.5 : 0.64 : 9.5 : 0.25 : ..... 0.54 : ..... 8.4 : 92.0 : 52 : 50 : 58.0 : ..... |         |         |                             |                 |                                    |                            |                    |         |                      |                                 |                              |                      |                     |                 |                |                |                |     |    |      |
| PAPERS CONTAINING 90 PERCENT BLENDED   |         |         |                             |                 |                                    |                            |                    |         |                      |                                 |                              |                      |                     |                 |                |                |                |     |    |      |
| 4238   | 90      | 10      |                             |                 | 125                                | 100                        | 39.4               | 34.0    | 4.1                  | .53                             | 9.3                          | .24                  | 26.6                | .68             | 2              | 8.5            | 88.9           | 40  | 52 | 69.0 |
| 4239   | 60      | 10      |                             |                 | 145                                | 110                        | 38.1               | 32.9    | 3.5                  | .60                             | 9.5                          | .25                  | 29.5                | .77             | 4              | 8.9            | 88.2           | 47  | 58 | 68.7 |
| 4244   | 60      | 10      |                             |                 | 205                                | 160                        | 37.5               | 32.4    | 4.0                  | .52                             | 9.7                          | .26                  | 30.6                | .82             | 4              | 9.4            | 89.5           | 25  | 41 | 66.4 |
| 4237   | 60      | 10      |                             |                 | 200                                | 150                        | 39.4               | 34.0    | 3.8                  | .57                             | 12.2                         | .30                  | 35.0                | .89             | 8              | 10.0           | 86.5           | 58  | 47 | 67.5 |
| 4236   | 60      | 10      |                             |                 | 190                                | 170                        | 41.1               | 35.5    | 4.0                  | .57                             | 11.5                         | .28                  | 34.4                | .85             | 7              | 10.1           | 87.3           | 36  | 50 | 64.2 |
| 4245   | 30      | 10      |                             |                 | 195                                | 165                        | 37.8               | 32.7    | 4.0                  | .52                             | 10.1                         | .27                  | 33.7                | .90             | 5              | 8.7            | 89.5           | 17  | 34 | 62.3 |
| PAPERS CONTAINING 100 PERCENT HARDWOOD   |         |         |                             |                 |                                    |                            |                    |         |                      |                                 |                              |                      |                     |                 |                |                |                |     |    |      |
| 4250   | 75      |         |                             |                 | 170                                | 125                        | 37.9               | 32.8    | 4.0                  | .52                             | 8.5                          | .22                  | 19.7                | .92             | 2              | 8.0            | 88.7           | 26  | 41 | 66.8 |
| 4242   | 75      |         |                             |                 | 170                                | 110                        | 38.1               | 32.9    | 4.0                  | .53                             | 9.5                          | .25                  | 21.0                | .56             | 3              | 8.7            | 87.8           | 29  | 45 | 68.6 |
| 4243   | 75      |         |                             |                 | 170                                | 125                        | 38.7               | 33.4    | 4.0                  | .54                             | 8.2                          | .21                  | 21.3                | .54             | 2              | 8.0            | 89.5           | 31  | 46 | 66.5 |
| PAPER CONTAINING 80 PERCENT BLENDED  |         |         |                             |                 |                                    |                            |                    |         |                      |                                 |                              |                      |                     |                 |                |                |                |     |    |      |
| 4247   | 50      | 20      |                             |                 | 150                                | 110                        | 37.5               | 32.4    | 4.1                  | .51                             | 9.1                          | .24                  | 36.8                | .96             | 5              | 7.9            | 89.5           | 24  | 42 | 63.3 |
| PAPERS WITH 5 PERCENT CLAY ADDED   |         |         |                             |                 |                                    |                            |                    |         |                      |                                 |                              |                      |                     |                 |                |                |                |     |    |      |
| 4249   | 60      | 10      |                             |                 | 160                                | 160                        | 39.3               | 34.0    | 4.0                  | .54                             | 10.0                         | .26                  | 33.3                | .85             | 3              | 8.8            | 88.6           | 22  | 40 | 67.4 |
| 4240   | 60      | 10      |                             |                 | 165                                | 165                        | 39.6               | 34.2    | 3.9                  | .56                             | 9.9                          | .25                  | 32.2                | .83             | 5              | 9.3            | 88.2           | 29  | 46 | 69.8 |
| 4239   | 60      | 10      |                             |                 | 135                                | 135                        | 38.6               | 34.2    | 3.8                  | .58                             | 9.3                          | .23                  | 31.7                | .79             | 4              | 8.7            | 90.2           | 36  | 48 | 67.8 |
| HIGHER RANGE OF CALIBERING   |         |         |                             |                 |                                    |                            |                    |         |                      |                                 |                              |                      |                     |                 |                |                |                |     |    |      |
| 4241   | 60      | 10      |                             |                 | 165                                | 165                        | 39.5               | 34.1    | 3.4                  | .64                             | 8.3                          | .21                  | 29.9                | .76             | 3              | 7.7            | 87.6           | 37  | 47 | 70.1 |
| 4246   | 30      | 10      |                             |                 | 195                                | 165                        | 37.1               | 32.0    | 3.4                  | .60                             | 7.2                          | .19                  | 27.7                | .74             | 3              | 7.3            | 86.0           | 22  | 38 | 62.8 |
| 4248   | 50      | 20      |                             |                 | 150                                | 110                        | 38.2               | 33.0    | 3.9                  | .54                             | 7.1                          | .19                  | 30.7                | .80             | 3              | 7.1            | 88.7           | 31  | 42 | 63.9 |

To convert to newsprint trade ream, 24 by 36 - 500, multiply by 1.157.  
 25 percent clay added to beater stock.