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# KRAFT PULPING OF DIGGER AND KNOBCONE PINE

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## Abstract

Kraft pulps made from Digger and knobcone pine had high bursting and tensile strengths with low resistance to tear, and were comparable to kraft pulps made from most northern softwoods.



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## Introduction

Digger pine (*Pinus sabiniana* Dougl.), which is found only in California, and knobcone pine (*P. attenuata* Lemm.), which is common to Oregon and California, grow in mixed stands with Douglas-fir and other softwoods. Because these species do not grow very tall and have several main stems with large branches, they are not used for sawlogs. Their only use now is for firewood and as soil holders in watershed protection.

This study was undertaken to determine if these species, either individually or in mixtures of naturally occurring softwoods, could be utilized to produce kraft pulps of good yields and quality.

## Experimental

### The Wood

Seven logs of Digger pine and 17 logs of knobcone pine were obtained, through the cooperation with the Pacific Southwest Forest and Range Experiment Station, from the Shasta-Trinity National Forest in California. One-inch disks were cut from the ends of each log and used to determine average age, diameter, specific gravity, and the amounts of heartwood and bark. Each of the logs was peeled and converted into nominal 5/8-inch chips. After screening, the chips were thoroughly mixed and samples taken for chemical analyses.

### Kraft Pulping and Bleaching

Kraft pulps with permanganate numbers around 30 for brown paper grades and around 20 for bleachable grades were made from both species. The pulps with the lower permanganate number were bleached to about 87 percent brightness using five stages (chlorine, caustic soda extraction, chlorine dioxide, caustic soda extraction, and chlorine dioxide). The unbleached and bleached pulps from both species were beaten in a laboratory beater and the handsheets were tested for strength properties.

## Results

As shown in table 1, the Digger pine had a very fast growth rate of four rings per inch while the knobcone pine had a slow growth rate of 13.9 rings per inch. Since the older slow-growth knobcone pine had about 14 percent higher specific gravity and only about 60 percent as much bark as the Digger pine with essentially the same chemical composition, the knobcone pine would be more desirable for pulpwood.

The amount of active alkali used to cook these woods was about equal to that required by Douglas-fir and the yields were slightly higher. The Digger pine

pulps had slightly higher yields than the knobcone pine pulps at comparable levels of permanganate number (table 2).

Compared to Douglas-fir kraft pulps, the Digger pine pulps were higher in bursting and tensile strength but lower in tearing resistance. Lowering of the permanganate number of the Digger pine pulps from 33.2 to 19.7 caused no appreciable change in the bursting and tensile strengths, but did increase the resistance to tearing by about 15 percent.

The knobcone pine pulps had bursting and tensile strengths similar to the Digger pine pulps, while the tearing resistance of the knobcone pine pulps was about 25 percent higher. As with the Digger pine pulps, the bursting and tensile strengths of the knobcone pine pulps did not change significantly in lowering the permanganate number from 32.2 to 19.5 while the tearing resistance did increase about 15 percent.

Bleaching of both the Digger and knobcone pine pulps did not affect the strength properties significantly.

These pulps, with high bursting and tensile strengths and low tearing resistance, compare with kraft pulps from most northern softwoods and could be used in many grades of paper now made with northern softwood kraft pulps. Pulps from mixtures of Digger and knobcone pine and Douglas-fir should have properties nearly proportional to the relative amounts in the mixture.

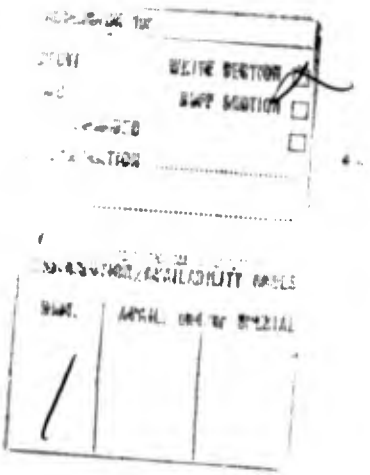

Table 1.--Physical properties and chemical composition of digger and knobcone pine

| Item | Wood | |
|---|---|---|
| | Digger pine | Knobcone pine |
| Physical properties (average): | | |
| Diameter of logs without bark ..... inches | 5.8 | 5.5 |
| Age of logs ..... years | 12 | 39 |
| Rate of growth ..... rings per inch | 4.0 | 13.9 |
| Specific gravity[1] ..... | 0.37 | 0.42 |
| Heartwood content (by volume) .....percent | 27.0 | 54.0 |
| Bark (by volume)[2] .....percent | 18.3 | 11.1 |
| Bark (by weight)[2] .....percent | 15.6 | 11.2 |
| Chemical composition[3]: | | |
| Lignin .....percent | 26.7 | 26.7 |
| Holocellulose .....percent | 70.0 | 69.0 |
| Alpha-cellulose .....percent | 46.7 | 46.9 |
| Pentosans .....percent | 10.2 | 10.4 |
| Solubility in: | | |
| Alcohol-benzene .....percent | 1.0 | 1.4 |
| 1 percent sodium hydroxide .....percent | 11.3 | 11.3 |
| Hot water .....percent | 2.3 | 2.8 |
| Ash .....percent | 0.1 | 0.2 |

[1] Moisture-free weight and green volume basis.

[2] Moisture-free basis.

[3] Analysis made on samples of chips used for pulping; percentages based on moisture-free wood.

Table 2.--Pulping[1] of digger and knobcone pine

| Digestion No. | Active alkali[2] | Yield[2] | | Black liquor | | Permanganate No. | Physical properties of hand sheets[3] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Beating time at freeness of | | Burst factor at freeness of | | Tear factor at freeness of | | Breaking length at freeness of | | Density at freeness of | |
| | | Total | Screenings | NaOH ($Na_2O$) | $Na_2S$ ($Na_2O$) | | 600 | 450 | 600 | 450 | 600 | 450 | 600 | 450 | 600 | 450 |
| | Pct. | Pct. | Pct. | G/l. | G/l. | | Min. | Min. | | | | | m | m | G/cc | G/cc |
| **DIGGER PINE** | | | | | | | | | | | | | | | | |
| 4117X,4125X: | 14.0 | 51.3 | 1.3 | 3.8 | 3.7 | 33.2 | 44 | 61 | 91 | 94 | 85 | 80 | 11,900 | 12,200 | .75 | .79 |
| 4121X | 15.0 | 49.6 | 0.5 | 5.4 | 4.0 | 28.8 | 40 | 56 | 87 | 93 | 89 | 78 | 11,500 | 12,100 | .76 | .80 |
| 4127X,4131X: | 16.5 | 48.0 | 0.3 | 6.8 | 5.5 | 23.3 | 52 | 75 | 84 | 87 | 80 | 74 | 11,700 | 12,300 | .77 | .80 |
| 4126X,4128X: | 17.0 | 46.9 | 0.2 | 7.7 | 4.6 | 19.7 | 34 | 51 | 84 | 91 | 99 | 86 | 11,300 | 12,300 | .78 | .80 |
| Bleached[4] | | | | | | | 28 | 49 | 85 | 92 | 97 | 82 | 10,800 | 11,600 | .79 | .82 |
| **KNOBCONE PINE** | | | | | | | | | | | | | | | | |
| 4152X,4157X: | 13.5 | 51.0 | 2.5 | 3.7 | 4.1 | 34.1 | 40 | 59 | 89 | 96 | 118 | 103 | 12,100 | 12,400 | .69 | .73 |
| 4154X,4155X: | 14.0 | 50.4 | 1.6 | 4.3 | 4.3 | 32.2 | 39 | 55 | 88 | 97 | 124 | 99 | 11,500 | 12,500 | .68 | .72 |
| 4150X,4158X: | 15.0 | 48.7 | 0.7 | 5.2 | 4.5 | 28.5 | 33 | 51 | 88 | 90 | 118 | 108 | 11,300 | 11,500 | .72 | .73 |
| 4149X,4159X: | 17.0 | 46.9 | 0.3 | 7.6 | 5.6 | 23.6 | 33 | 54 | 81 | 90 | 130 | 117 | 11,300 | 11,900 | .71 | .73 |
| 4147X,4151X: | 18.0 | 46.3 | 0.3 | 9.3 | 6.1 | 19.5 | 32 | 49 | 82 | 88 | 131 | 119 | 10,600 | 11,400 | .70 | .73 |
| Bleached[5] | | | | | | | 21 | 35 | 81 | 90 | 124 | 112 | 10,700 | 11,200 | .77 | .78 |

[1] Constant conditions used were 4 to 1 liquor-to-wood ratio, 25 percent sulfidity, 90 minutes from 30° to 170° C., and 90 minutes at 170° C.

[2] Moisture-free wood basis.

[3] Tested according to TAPPI methods except that handsheets were pressed only once and a basis weight of 72 grams per square meter was used.

[4] Bleached to a brightness of 87.1 percent using 6.4 percent chlorine and 1.0 percent chlorine dioxide in a 5-stage sequence.

[5] Bleached to a brightness of 87.4 percent using 6.2 percent chlorine and 1.0 percent chlorine dioxide in a 5-stage sequence.