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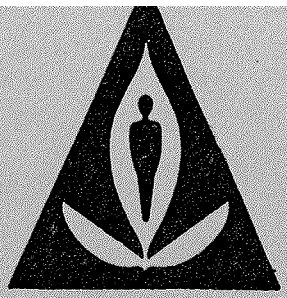


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FOREST PRODUCTS LABORATORY
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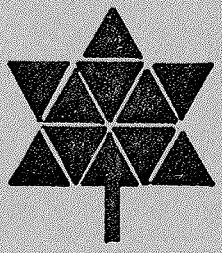

Department of Forestry and Rural Development
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## ABSTRACT

The various possibilities for utilizing *Populus tremuloides* Michx. (referred to as aspen in the present text) as a raw material for pulp and paper manufacture are considered. It is suggested that the most promising possibility lies in the manufacture of newsprint, using aspen refiner groundwood as the mechanical pulp component. A second possibility warranting study is the manufacture of market kraft, using aspen and such coniferous species as may be available.

A three-stage analysis of the problem under consideration is recommended:

1. an appraisal of the general conclusions and recommendations set forth in the present report;
2. a preliminary feasibility study on the use of aspen for the manufacture of newsprint and/or market kraft, should the stage 1 study so indicate;
3. a detailed feasibility study of the most promising alternative indicated by the preliminary feasibility study.

The general form for a preliminary feasibility study is outlined.

## INTRODUCTION

In the present report broad consideration is given to the various possibilities for the utilization of aspen in the manufacture of pulp and paper. As general background, several basic assumptions have been made:

1. that there are in Canada sufficient reserves of aspen to provide a fibre raw material base for one or more pulp and/or paper mills, each with a capacity of the order of 100,000 to 200,000 tons per year;
2. that the need of the market places of the world for pulp-and-paper products will continue to expand up to and beyond the year 2,000, and will be of such magnitude within 50 years that the present fibre resources of the world will scarcely suffice to meet the demand[1];
3. that a problem exists in the need to develop industries in the general areas where aspen is found in abundance, and that there is a realistic possibility that the wood reserves of these areas can be harvested and transported to selected mill sites at reasonable cost.

Based on the above broad assumptions, on a review of the technical literature relating to the pulping of aspen, and on general background experience in the pulp and paper field, the potential use of aspen as a raw material for the manufacture of substantial tonnages of pulp and/or paper products has been analyzed in broad terms.

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[1] Appendix I shows projected demand for pulp-and-paper products to the year 1975 based on F.A.O. estimates, and to the year 2,220 based on the concept of "critical year".

## Possibilities for the Use of Aspen in the Manufacture of Pulp and Paper

World production of the various types of pulps is shown in Table 1.

TABLE I

World Production of Pulp by Grades - 1960[2]

| Type of Pulp | Per Cent of Total | Production in Millions of Tons per Year |
|---|---|---|
| Kraft | 34 | 21.4 |
| Unbleached | 21 | |
| Bleached | 13 | |
| Mechanical | 24 | 15.1 |
| Sulfite | 21 | 13.2 |
| Unbleached | 12 | |
| Bleached | 9 | |
| Miscellaneous* | 11 | 6.9 |
| Dissolving Grade | 5 | 3.2 |
| Semichemical | 4 | 2.5 |
| Soda | 1 | 0.6 |
| TOTAL | 100 | 62.9 |

* Includes pulp from straw, bamboo, bagasse, etc., as well as exploded or defibrated pulps.

The use of aspen in each of the pulp categories listed in Table I is considered briefly below.

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2 Rydholm, S.A., Pulping Processes - Interscience Publishers, New York, p. 1190, 1965.

Soda

Soda pulp is of minor and decreasing importance, and need not be considered further in the present context.

Semichemical[3]

Aspen can be pulped readily by the neutral sulfite semichemical process to give a pulp suitable for a variety of end products, including corrugating medium (its principal use), papers and board. In actual fact, a large part of the 2.5 million tons of semichemical pulp shown in Table I was produced from aspen or from wood species similar in pulping characteristics. However, the selling price of corrugating medium is not as high as that of such products as bleached market kraft or newsprint and transportation costs could be a critical factor. The possibility that large reserves of aspen could be utilized economically for the production of neutral sulfite semichemical pulp is considered to be low.

Dissolving-Grade Pulps

Dissolving-grade pulps can be prepared from deciduous woods by the sulfite process, and approximately 20% of the dissolving-grade pulps are so produced (from birch, beech and the eucalyptus). However, even if fully satisfactory dissolving-grade pulps could be produced from aspen, the field is not a promising one. The dissolving-pulp field is complex, competitive and difficult to enter. Aspen does not have any natural advantages over a number of other wood species for the manufacture of dissolving pulps, and the possibility of its use for this purpose is considered to be low.

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[3] Pulp and paper terminology can be confusing. Semichemical pulps can include those prepared by the sulfite, kraft, and soda processes. In the present text, semichemical pulp refers to pulp produced by means of bisulfite-carbonate liquors within the 5 to 9 pH range.

Sulfite Pulp

Aspen can be used for sulfite pulp manufacture, but the possibility of doing so on a massive scale, and with high investment return, is considered to be low for two reasons:

- aspen does not yield a sulfite pulp equal in strength characteristics to those of the sulfite pulps produced from the softwoods;
- sulfite pulp production is, in general, declining[4]. Almost all of the massive expansion presently underway in British Columbia in pulp manufacture, for example, will be in the field of market kraft pulp manufacture, and no new sulfite mills are planned as a part of this expansion. In general, the trend is either to close down old and uneconomical sulfite mills completely (as is being done increasingly in the Scandinavian countries) or to replace them with kraft mills. This trend is evident in the pulp-and-paper industry of the Soviet Union, which will expand its pulp production by five million tons by 1970 and by an additional 20 million tons within the following decade. Although some dissolving-grade sulfite mills, utilizing softwoods, will be installed in Siberia, the bulk of the expansion will involve kraft, neutral sulfite semichemical and mechanical pulps for newsprint.

Kraft Pulp

As shown in Table I, kraft pulp accounts for one third of all pulp produced in the world today and it has the highest potential of any of the conventional pulping processes. However, the preferred kraft, with the highest market potential and the highest selling price, is kraft from

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[4] The relative growth rates for sulfite and kraft pulps are given in Appendix II.

coniferous wood species. There is a market for deciduous kraft pulps (in such end products as fine and coarse papers, tissue, etc.), although in some products (such as linerboard) it is not competitive with softwood kraft.

Approximately 80% of the kraft produced in the world today comes from softwood species. These pulps are superior in quality to other pulps available, but they are also higher in price and there is a long-range trend towards:

- a higher per cent of mechanical, semichemical and hardwoods in newsprint and printing papers;
- a higher per cent of hardwood fibres in fine papers;
- increasing amounts of high-yield kraft and neutral sulfite semichemical pulps in container-board manufacture;
- an increased use of hardwood in dissolving-grade pulps.

These trends may be of limited importance today, but their importance is increasing. In spite of its limitations, hardwood kraft has a high potential for the future, and the possibility of building up markets for aspen kraft are considered to be sufficiently promising that it should receive further study.

Newsprint

It is assumed that future quality requirements of newsprint will be those presently met by West Coast newsprint manufacturers, and that newsprint of this quality will meet the demands of the market place within the foreseeable future. It is further assumed that the mechanical pulp

component of such a newsprint can be manufactured from aspen[5].

A newsprint containing conventional stone groundwood from aspen and say 25% coniferous kraft might have excellent printing characteristics but it would not have the strength required by today's high-speed newsprint presses. It is believed, however, that a newsprint containing 70 to 80% refiner groundwood from aspen chips together with 20 to 30% softwood kraft could be fully competitive in printing and press room runability characteristics, strength, brightness, show through, cleanliness, etc., with any newsprint presently on the market. Whether or not the chemical component of an aspen refiner-groundwood newsprint would be imported kraft, or kraft produced in an integrated kraft-newsprint complex at the same site (say from jack pine), or from a kraft mill located within the same general region and shipping kraft pulp to the newsprint mill, are all questions which would have to be answered by further study.

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5 The problem of how Canadian forest resources should be utilized to best serve the long-term interests of the Canadian economy is obviously a highly complex one. However, there is a fundamental principle involved which has a direct and critical bearing on the problem: if aspen can yield a high-quality newsprint, but also yields other products (such as kraft) of low quality, and if the softwoods yield products (such as kraft) of high quality and massive market potential, as well as a higher selling price, then in the interests of optimum return from Canada's forest resources, aspen should be converted to newsprint, and the softwoods should be converted to market kraft. This is simply on application of the general principle of the highest level of utilization.

## SUMMARY

The general points raised in the above are summarized qualitatively in Table II.

Table II

The Suitability of Various Pulping Processes

As Applied to Aspen

| Type of Pulp | Suitability of Aspen as a Raw Material | Long-range Market Potential | Market Price |
|---|---|---|---|
| Kraft | Moderate | High | High |
| Mechanical (Newsprint) | Low for conventional groundwood<br>Believed to be high for refiner groundwood[6] | High | High |
| Sulfite | Moderate | Moderate to poor | Moderate |
| Dissolving Grade | Moderate to poor | Moderate | High |
| Neutral Sulfite Semichemical | High | Moderate to high | Low |
| Soda | Moderate | Low | Moderate |

[6] It is not suggested that aspen fibers are equal in strength to softwood fibres .... or can be made so. It is suggested that a newsprint containing 75% aspen refiner groundwood and 25% semi-bleached kraft could be made equal in strength to a newsprint containing 25% semi-bleached kraft and 75% conventional stone groundwood from say, western hemlock.

It is concluded that of the pulping processes touched upon above, two are of sufficient promise with respect to large-scale utilization of aspen to warrant further serious study. These two processes are:

- refiner groundwood from chips for the manufacture of newsprint;
- kraft pulp, either for the manufacture of a market pulp alone, or in conjunction with a newsprint mill, involving the use of aspen and such coniferous woods as may be available.

## RECOMMENDATIONS

In order to determine the feasibility of establishing one or more pulp and/or paper mills in those regions with large reserves of aspen, the following three-stage approach is recommended:

1. An independent appraisal of the various conclusions and recommendations presented in the present report. This will involve an examination in some depth of the various possibilities for use of aspen in pulp-and-paper manufacture;
2. A preliminary economic feasibility study of those possibilities which are considered to warrant further study, such as the manufacture of newsprint or market-kraft pulps. This preliminary feasibility study would include an analysis[7] in terms of:

   Raw Material;

   Markets;

   Mill Location;

   Processing;

   Capital Costs;

   Manufacturing Costs;

   Investment Return.

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[7] Appendix III gives a more detailed outline of the type of information which would be included in the preliminary feasibility study.

3. A detailed feasibility study of the most promising alternative as shown by the preliminary economic feasibility study.

It is recommended that each of the three successive steps outlined above be undertaken by an engineering-consulting firm with knowledge and experience in this type of broad-ranging feasibility analysis. As a rough guide to costs, it is estimated that the appraisal of potential should cost somewhere in the thousands of dollars, and the preliminary feasibility study in the tens of thousands of dollars. No estimate can be given as to the possible costs of a final and detailed feasibility study, since this will depend upon a large number of variables whose dimensions will be known only after the first two studies have been completed.

APPENDIX I

Future Demand for Pulp, Paper and Paperboard

Table III gives an F.A.O. estimate for future world requirements for pulp and paper products.[8]

Table III

A Tentative Forecast of Paper and Board Demand: 1965 and 1975

*1,000 metric tons*

| Region | Newsprint | | | Printing and writing | | | Other paper | | | Paperboard | | | Total paper and board | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1955 | 1965 | 1975 | 1955 | 1965 | 1975 | 1955 | 1965 | 1975 | 1955 | 1965 | 1975 | 1955 | 1965 | 19 |
| North America | 6,351 | 8,170 | 10,565 | 5,073 | 6,715 | 8,925 | 7,175 | 9,585 | 12,900 | 12,923 | 18,315 | 26,220 | 31,522 | 42,785 | 58,( |
| Latin America | 495 | 970 | 1,790 | 327 | 620 | 1,155 | 647 | 1,190 | 2,180 | 353 | 700 | 1,405 | 1,822 | 3,480 | 6,: |
| Western Europe | 2,648 | 4,600 | 6,515 | 2,847 | 4,380 | 5,875 | 4,386 | 6,725 | 9,240 | 3,272 | 5,595 | 8,585 | 13,153 | 21,300 | 30,: |
| Eastern Europe | 222 | 505 | 950 | 368 | 755 | 1,310 | 765 | 1,445 | 2,355 | 535 | 1,240 | 2,440 | 1,890 | 3,945 | 7,( |
| U.S.S.R. | 307 | 835 | 1,780 | 496 | 1,205 | 2,375 | 1,097 | 2,420 | 4,435 | 575 | 1,650 | 3,755 | 2,475 | 6,115 | 12,: |
| Africa | 102 | 190 | 345 | 88 | 160 | 290 | 225 | 405 | 705 | 71 | 140 | 265 | 486 | 890 | 1,( |
| Near and Middle East | 31 | 65 | 120 | 23 | 45 | 90 | 53 | 100 | 180 | 32 | 65 | 135 | 139 | 275 | : |
| Far East | 672 | 1,505 | 2,920 | 796 | 1,685 | 3,145 | 758 | 1,645 | 3,100 | 766 | 2,045 | 4,670 | 2,992 | 6,880 | 13,( |
| China (Mainland) | 141 | 540 | 1,625 | 303 | 1,005 | 2,670 | 254 | 860 | 2,350 | 170 | 680 | 2,180 | 868 | 3,085 | 8,( |
| Oceania | 310 | 460 | 600 | 116 | 190 | 270 | 152 | 255 | 375 | 182 | 360 | 590 | 760 | 1,265 | 1,( |
| WORLD TOTAL | 11,280 | 17,840 | 27,210 | 10,430 | 16,760 | 26,100 | 15,510 | 24,630 | 37,820 | 18,870 | 30,790 | 50,250 | 56,090 | 90,020 | 141,: |

World Demand for Paper to 1975, FAO Report, 1960, p. 51.

The F.A.O. report gives a relatively short-term projection for world requirements of pulp and paper in the future. For a long range projection, the concept of "Critical year"[9], is of interest. The "critical year" is that point on the growth curve of a product at which the slope is zero ... that is, the point in time where the product levels off and begins to decline. Table IV gives the critical year and per cent growth rate for several selected products.

Table IV

Critical Year and Growth Rate for Selected Industries

| Industry | Critical Year | Growth Rate % 1948-1958 |
|---|---|---|
| Electrical energy | 2029 | 5.6 |
| Natural gas | 2151 | 5.6 |
| Aluminum | 2022 | 7.5 |
| Paper and paperboard | 2219 | 4.1[10] |
| Life insurance | 2522 | 6.7 |

According to Table IV, the paper and paperboard industry is a "young" industry, exceeded only by life insurance in the time required to reach full maturity.

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9 J. Frank Gaston, Growth Patterns in Industry: A re-examination, N.I.C.B. Report - Studies in Business Economics, No. 75, December, 1961.

10 This value is lower than the F.A.O. projection for the 1955-1975 period - (4.7%) World Demand for Paper to 1975, FAO Report, 1960, p. 51.

On the assumption that the present growth rate of the paper and paperboard industry is four per cent, and that the present world production of paper and paperboard is roughly one hundred million tons per year[11], world demand for paper-and-paperboard products has been calculated to the critical year in Table V.

Table V

Future World Demand for Paper and Paperboard Based on the Concept of Critical Year

| Year | Assumed Growth Rate[12] % | Production of Paper and Paperboard - Millions of tons |
|---|---|---|
| 1965 | 4.00 | 100 |
| 1970 | 3.92 | 120 |
| 1980 | 3.76 | 167[13] |
| 1990 | 3.60 | 230 |
| 2000 | 3.44 | 313 |
| 2010 | 3.28 | 420 |
| 2020 | 3.12 | 558 |
| 2030 | 2.96 | 732 |
| 2040 | 2.80 | 948 |
| 2050 | 2.64 | 1210 |
| 2060 | 2.48 | 1530 |
| 2070 | 2.32 | 1920 |
| 2080 | 2.16 | 2360 |
| 2090 | 2.00 | 2870 |
| 2100 | 1.84 | 3440 |
| 2120 | 1.52 | 4710 |
| 2140 | 1.20 | 6140 |
| 2160 | 0.88 | 7620 |
| 2180 | 0.56 | 8960 |
| 2200 | 0.24 | 9960 |
| 2220 | 0 | 10440 |

11 Yearbook of Forest Products Statistics. F.A.O., 1966, p. 37.

12 Average growth rate used over the period indicated; i.e. 5, 10, or 20 years.

13 A late estimate for paper and paperboard gives a figure of 225 million tons by 1980 (compared with the 167 million tons shown) (Pulp and Paper, 16th Annual World Review, 40, No. 29, July 18, 1966, p. 9).

The estimates shown in Table V are not intended to be predictive except, perhaps, by order of magnitude. They do indicate, however, that within 50 years, or by 2020, the world demand for pulp, paper and paperboard products[14] will by five to six times what it is today, and that by the middle of the 21st Century it will be 10 to 15 times what it is today. If Canada is to obtain its share of the markets created by this demand, and it is reasonable to assume that it will, then wood species such as aspen will <u>have</u> to be used, and the critical question will be how to use them at optimum investment return.

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14 The terms "Paper and Paperboard" and "Pulp, Paper and Paperboard" have been used more or less interchangeably in the present report. Differences between the two figures arise from the fact that considerable waste paper (approximately 20%) is reused, so that 80 million tons of pulp, say, will yield approximately 100 million tons of paper-and-paperboard products.

## APPENDIX II

### Growth Rate for Sulfite and Kraft Pulps in the United States and Canada

Table VI shows the tonnages of kraft and sulfite pulps produced in Canada and the United States (combined) for selected years. Figure I shows the relative rates of growth for the two types of pulps.

### Table VI

Production of Kraft and Sulfite Pulps -

(1000's of metric tons)

United States and Canada[15]

| Year | Total Sulfite Pulp Production Millions of Tons | Total Kraft (plus soda pulp) Production Millions of Tons |
|---|---|---|
| 1958 | 4,180 | 13,380 |
| 1959 | 4,210 | 15,120 |
| 1960 | 4,480 | 15,910 |
| 1961 | 4,570 | 17,070 |
| 1962 | 4,470 | 17,990 |
| 1963 | 4,800 | 19,160 |
| 1964 | 5,060 | 21,670 |
| 1965 | 5,190 | 22,340 |

15 Yearbook of Forest Products Statistics (F.A.O), selected issues.

## APPENDIX III

### General Outline for a Preliminary Feasibility Study

Following is an outline of the areas which would be included in a preliminary feasibility study dealing with the possibility of developing a pulp-and-paper industry based on the use of aspen and such coniferous wood species as may be available in the areas under study:

Raw Material

- availability of wood by species, age and quality classification;
- wood costs to potential mill sites, including road systems available or required;

Markets

- present and both short-term and long-term markets for newsprint; for various types of kraft, softwood and hardwood, bleached, semi-bleached and unbleached and for both normal and high-yield kraft pulps;
- markets in which the mills under consideration might be expected to compete;
- anticipated alternative sources of supply, present or future, for the product markets under consideration;

Mill Location

- potential mill sites;
- availability and cost of land, transport, electricity (of particular importance in newsprint manufacture) and water supply (amount and purity);
- effluent disposal, including regulatory requirements;
- personnel procurement, accommodations, amenities, etc.;

Processing

- basic processing flows;
- equipment size and type, including all primary and ancillary processing components;
- general mill lay-out;
- availability of chemicals and other materials for mill operations;

Capital Costs

- site clearing;
- building;
- machinery and equipment;
- services, including rail lines, roads, power, water, and requirements for effluent disposal;

Operating Costs

- direct operating and maintenance costs;
- administration and overhead;
- sales costs;
- quality control and research;

Investment Return

- based on estimated manufacturing costs, capital costs, selling price and sales volume, investment return can be calculated in any desired form.

Special concessions in the form of reduced stumpage, tax remission etc. would be included in the preliminary feasability study.

The above outline is not intended to be definitive. It does, however, provide a general guide as to the types of questions which have to be answered before a prospective manufacturer of pulp and/or paper could

be approached. It is assumed that other critical factors, including such diverse items as tariff considerations, machine operating efficiency, site suitability in terms of foundation conditions, working capital requirements, would be covered by the engineering consulting firm undertaking the potential and preliminary feasibility study.

FIGURE 1 PRODUCTION OF SULFATE AND SULFITE PULPS