POLLUTION CONTROL AND CHEMICAL RECOVERY IN THE PULP AND PAPER INDUSTRY

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FOREWORD

This Pollution Technology Review is based on authoritative government reports and U.S. patents. It attempts to clarify the ways and means open to the alert paper manufacturer who must keep his polluting wastes down to a minimum.

Many effluent wastes from paper mills are biodegradable, but treatment costs are increasing, effluent discharge requirements are becoming more stringent, and urbanization increasingly limits the availability of land. Thus, there are many problems to be dealt with in handling the industry's waste.

In the United States, we are fortunate in receiving direct help from the numerous surveys, together with active research and development programs that are being supported by the Federal Government to help industry control its wastes and troublesome effluents.

In this book are condensed vital data from government sources of information that are scattered and difficult to pull together. Important processes are interpreted and explained by examples from 54 U.S. patents. One should have to go no further than this condensed information to establish a sound background for action towards combating pollution in the pulp and paper industry.

Advanced composition and production methods developed by Noyes Data are employed to bring these durably bound books to you in a minimum of time. Specialized techniques are used to close the gap between "manuscript" and "completed book." Industrial technology is progressing so rapidly that time-honored, conventional typesetting, printing, binding and shipping methods can render a technical or scientific book quite obsolete before the potential user gets to see it.

The Table of Contents is organized in such a way as to serve as a subject index. Other indexes by company, inventor and patent number help in providing easy access to the information contained in this book.

CONTENTS AND SUBJECT INDEX

INTRODUCTION

In the realm of pollution control, one of the prime targets — perhaps the No. 1 target — is the paper industry.

This was highlighted by a controversial report issued by the Council on Economic Priorities, a Washington, D.C.-based nonprofit corporation in late 1970. That study claimed that only two of the twenty-four largest paper companies in the U.S. had made substantial efforts to control air and water pollution and that the industry would have to spend $750 million to meet acceptable pollution control standards. It was admitted that the industry had committed some $480 million for abatement programs.

The first report of the Council on Economic Priorities was answered in a report by the American Paper Institute of New York City. It pointed out water pollution control expenditures of nearly $500 million and air pollution control expenditures of some $170 million as of the end of 1970. It went on to point out that these efforts were buttressed by intensive efforts and resultant progress in forest management and in the reuse of wastepaper.

In the summer of '72, the Council on Economic Priorities issued a second report which reported that the pulp and paper industry had made changes which put it "years ahead of other industries in pollution control."

The problem is not a simple one, however, and national performance figures may be impressive but little comfort to an area with a pollution problem from a specific mill.

In the first place, the pulp and paper industry has serious problems to solve, both in the air pollution and water pollution areas. Earlier books in this

series have dealt with:

...the nonferrous metals industry which has a substantial air pollution problem, largely with SO_2, and very little water pollution problem.

...the fruit and vegetable freezing and canning industry which has a substantial water pollution problem but few air pollution problems.

...the textile industry which also has a substantial water pollution problem but few air pollution problems.

In contrast, the pulp and paper industry has a big air pollution problem with a variety of sulfur compounds plus particulates in its atmospheric emissions as well as a big water pollution problem.

In the second place, one mill may be a troublemaker of vast proportions in a particular area, even though the national control problem for all the plants in the industry is reasonably well in hand.

As an example of this latter point, a pollution control expert with a New York bank recently cited some data on the Connecticut River valley. He said that 65% of the pollution affecting the river was industrial and 35% was municipal. Of the 65%, however, 50 out of the 65% was due to the paper industry and 48 out of the 50% was due to one single mill. When one considers the economics of cleanup, the impact is even harder.

The capital cost of cleaning up all the municipal effluents was estimated at $365 million. The capital cost of cleaning up all the industrial effluents was $135 million. However, the one mill responsible for 48% of total river pollution could be cleaned up for $5 million, according to estimates. Thus almost half the total river cleanup could be accomplished for 1% of the total bill for industrial plus municipal control.

Thus, understanding, identification and economic control procedures applied to pulp and paper mills are an important part of improving the environment.

THE NATURE AND GROWTH OF THE INDUSTRY

In general, cellulose fibers derived from a variety of softwoods and hardwoods are the primary raw materials for paper and board making. A softwood is defined by the industry as wood from a coniferous or evergreen tree; a hardwood is defined as wood, regardless of its density or hardness, from any deciduous tree.

The two major constituents of wood are the cellulose fibers and the amorphous binder, lignin. The fibers may be separated by mechanical means, as in groundwood, or by chemical solution of the lignin as in a full chemical process such as the sulfite, soda and kraft (or sulfate) processes. Several combination pulping methods also exist of which the neutral sulfite semichemical process (NSSC) is the most widely used. If a bright, white pulp is required, residual lignin and derived color bodies are removed by a series of bleaching stages.

The pulp mill includes the fundamental processes of wood preparation, pulping, screening, washing, thickening, and bleaching, whereas the fundamental processes in the paper mill include stock preparation, paper machine operation, converting, and finishing.

Large quantities of water are used in the paper and board making operations to process the fibers and to disperse them prior to laying them down in a web on the paper machine forming wire.

To meet society's needs a paper industry of substantial magnitude has developed, made up of 383 companies which operate 842 mills at some 750 locations. Of this number, 542 are paper mills, 22 produce only pulp, and 278 are integrated mills which make both pulp and paper. In 1969 the

industry produced almost 54 million tons of paper and paperboard; production in 1970 was an estimated 52.4 million tons. In 1969 almost 700,000 men and women earned their living in the paper and allied products industry. Wages and other employee benefits came to $6.3 billion, and the total annual tax bill paid by the industry was $1.4 billion. The gross amount of money invested in the property, plant and equipment which employed these people totalled $17.2 billion. Sales were reported at $20.6 billion, equivalent to about 2.2% of the Gross National Product (GNP).

The paper industry, among America's 19 major manufacturing industries, ranked 13th in sales and 11th in number of employees as of 1969. It is a capital intensive industry requiring as much as $1.50 of capital investment for each dollar of annual sales; its return on investment has been only 7 to 8%.

Not only is the paper industry itself a major element in the manufacturing sector of the economy, but its supports a number of other major industries in its role as a supplier of materials. These include newspaper, periodical and book publishing, commercial printing, business forms manufacture, greeting card publishing and the packaging industry which produces the cartons and boxes essential for the distribution of food, appliances and the myriad other products which are delivered to the American consumer.

To meet the ever-increasing demand for paper and paper products, the American paper industry has doubled its production every 15 to 17 years. Per capita consumption has grown from 385 pounds of paper and paperboard in 1954 to 573 pounds in 1969.

The trend is toward establishing larger mills. On the average, mills producing less than 250 tons-per-day are considered small, 250 to 700 tons-per-day mills are considered medium, and more than 700 tons-per-day mills, large.

Data are presented in Table 1 which show the number of mills and total mill capacities for the five chemical pulping processes. In Table 1, all capacities are based on air dried tons of pulp; annual capacities are based on operating at rated capacity for 350 days per year, allowing for normal maintenance and scheduled shutdowns. It is emphasized that these figures represent production capability and do not portray actual production data.

The United States pulp and paper industry includes more than 360 pulp mills of all types, mechanical and chemical. Estimates for 1967 indicate 37 companies, each with pulp and paper sales at the manufacturer's level of at least $100 million, accounted for $10.24 billion in sales, or 49% of the industry's total of $20.88 billion.

TABLE 1: USA CHEMICAL PULP MILL CAPACITIES (UNBLEACHED)

Process	Number of Mills	Capacity* ADT/day	Annual Capacity* tons	1968 Production tons
Kraft	116	87,808	30,733,000	24,300,000
Sulfite	43	10,875	3,799,500	2,500,000
NSSC	43	10,675	3,736,500	3,500,000
Dissolving	8	4,565	1,600,000	1,500,000
Soda	4	570	200,000	200,000
Totals	214	114,493	40,069,000	32,000,000

*These figures as of December 31, 1968 represent capacity and not actual production. ADT stands for air-dried tons of unbleached pulp per day; air-dried pulp contains 10% moisture.

Source: Report PB 190,351

Table 2 shows the wood pulp production in 1968 for the ten leading pulp producing nations of the world. The other 60 pulp producing nations individually produced less than one million tons of pulp and collectively produced 13,441,000 tons of pulp in 1968. From these data, it can be determined that the U.S. and Canada produced 52% of the world's wood pulp in 1968. This massive capacity, coupled with the contiguous features of the U.S. and Canada, place these countries in a leading position in terms of production.

TABLE 2: PRODUCTION OF TEN LEADING PULP PRODUCING NATIONS — 1968

Nation	Million Short Tons
United States	37.89
Canada	16.40
Sweden	7.76
Japan	7.76
USSR	6.78
Finland	6.56

(continued)

TABLE 2: (continued)

Nation	Million Short Tons
Mainland China	2.30
Norway	2.18
France	1.77
West Germany	1.73

Source: Report PB 190,351

It is reported that North American industry is planning to build 65 new pulp mills in the early 1970's, 39 in the U.S. and 26 in Canada. It seems reasonable to conclude, therefore, that the U.S. and Canada will remain the dominant nations in wood pulp production at least for the next two or three decades.

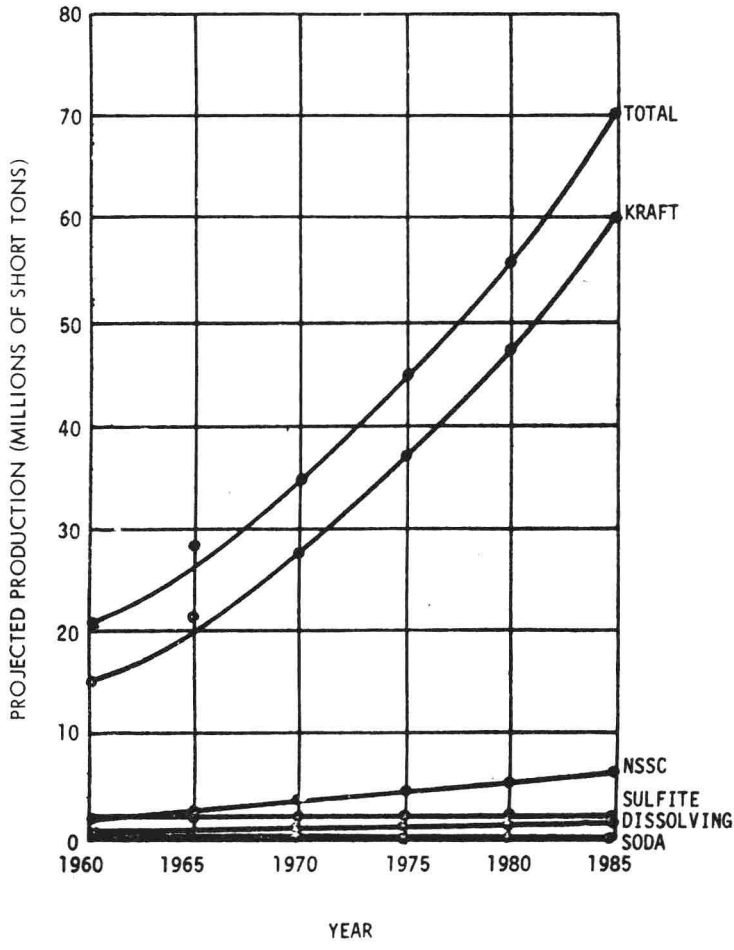
A number of forecasts have been made which attempt to portray the future demand for wood pulp (all grades) in the United States. These forecasts range from a low of 61 million tons to a high of 89 million tons per year in 1985.

A middle of the road forecast has been made by the American Paper Institute. Based on these data, plus numerous other sources, and a wealth of in-house knowledge, H.W. Meakin of the J.E. Sirrine Company has projected chemical pulp production through 1985. These projections are reproduced here as Figure 1 from the report "Control of Atmospheric Emissions in the Wood Pulping Industry," Vol. 1 by E.R. Hendrickson, J.E. Roberson, and J.B. Koogler, prepared under EPA contract by J.E. Sirrine Company and published as Report PB 190,351 by National Technical Information Services, Springfield, Virginia (March 15, 1970).

Viewed together, these data show that through 1985, the production of soda pulp and dissolving pulps will remain reasonably constant; sulfite pulp production will decrease slightly; NSSC production will nearly double, and kraft pulp will increase to approximately 2 1/2 times the 1968 amount.

In 1985, kraft and NSSC processes are expected to dominate chemical pulping in the United States. Kraft production is projected to account for about 85% of the chemical (about 70% of total wood pulp, all grades, production), and NSSC for about 9% of the total chemical pulp production. The total production of chemical pulp is expected to slightly more than

FIGURE 1: PROJECTION OF PRODUCTION OF CHEMICAL PULPS IN THE UNITED STATES



Source: Report PB 190, 351

double. Table 3 has been included to summarize announced and estimated expansion and phasing out operations through 1980. Table 4 contains information which shows the regional distribution of the industry as it was in 1968 as well as the projected distribution in 1975 and 1980. It appears to be the consensus of industry representatives on the Pulp Industry Liaison Committee that the distribution of pulp production in the foreseeable future (through 1985) will remain essentially as it is today. The projected

TABLE 3: ANNOUNCED AND ESTIMATED EXPANSION AND PHASING OUT PLANS THROUGH 1980

Current and Planned New Plant Construction as of December 31, 1968*

	Capacity ADT/Day		
	Kraft	Sulfite	NSSC
New	5,866 (12)	830 (2)	750 (3)
Expansion	2,135 (5)	0	568 (2)
Total	8,001 (17)	830 (2)	1,318 (5)

Estimate of Phased Out Operations

	Capacity ADT/Day			
Time Period	Kraft	Sulfite	NSSC	Soda
In 1968**		835 (5)		60 (1)
In 1969-1970	205 (1)	503 (3)	235 (1)	
In 1970-1980	85 (1)	1,562 (17)		140 (2)
Total	290 (2)	2,900 (25)	235 (1)	200 (3)

*Figures in ( ) indicate number of mills.
**These capacity figures for 1968 were not included in Table 1.

In addition to the current and planned new plant construction shown above, there are at least twelve proposed or tentative mills in the talking stage of development. These twelve mills would, if brought to production, supply in excess of an additional 3,000 tons per day of pulp.

Source: Report PB 190,351

chemical pulp production shown on Figure 1 was, therefore, stratified by region on the basis of this assumption. There are several factors which influence the decision to locate a pulp mill in a given section of the country.

One of these factors is the availability of trees to serve as raw material. Some concern has been expressed by forestry management people that a tightening of the wood supply in the South could occur in the late 1970's. If this were to occur, there could possibly be a shift of production to the West and North.

It is felt, however, that by more intensified management of the better forest lands and improved silviculture, appreciably more wood can be grown and thus satisfy the demands of the wood pulping industry. Thus, it is predicted that the distribution of chemical pulp production by regions will remain substantially as it is today.

TABLE 4: PROJECTION OF PULP PRODUCTION BY REGION IN THE UNITED STATES 1968 TO 1980

REGION	1968 Prod. TPD	1968 % of Indust. Prod.	1975 Prod. TPD	1975 % Growth Over 1968	1980 Prod. TPD	1980 % Growth Over 1968	1980 % Growth Over 1975
Kraft							
Northeast	3,617	5.21	5,582	54.3	6,981	93.0	25.1
Northcentral	2,319	3.34	3,579	54.3	4,476	93.0	25.1
Southeast	36,249	52.21	55,939	54.3	69,962	93.0	25.1
Southcentral	15,850	22.83	24,460	54.3	30,592	93.0	25.1
Northwest	11,393	16.41	17,582	54.3	21,989	93.0	25.1
TOTAL	69,428	100.0	107,142	54.3	134,000	93.0	25.1
Sulfite							
Northeast	1,464	20.49	1,171	(20.0)	1,171	(20.0)	0
Northcentral	1,354	18.96	1,083	(20.0)	1,083	(20.0)	0
Southeast	471	6.59	377	(20.0)	377	(20.0)	0
Southcentral	0	---	0	---	0	---	---
Northwest	3,854	53.96	3,083	(20.0)	3,083	(20.0)	0
TOTAL	7,143	100.00	5,714	(20.0)	5,714	(20.0)	0
NSSC							
Northeast	1,731	17.31	2,324	34.3	2,720	57.1	17.0
Northcentral	3,330	33.30	4,472	34.3	5,233	57.1	17.0
Southeast	2,926	29.26	3,929	34.3	4,598	57.1	17.0
Southcentral	1,283	12.83	1,723	34.3	2,016	57.1	17.0
Northwest	730	7.30	980	34.3	1,147	57.1	17.0
TOTAL	10,000	100.00	13,428	34.3	15,714	57.1	17.0

TPD stands for Tons Per Day
( ) Represents a decline in production

Source: Report PB 190,351

Another view of industry production trends with more delineation of the fine structure of the trends and with more emphasis on changes within the production figures to processes emphasizing water reuse and recovery is shown in Table 5. This table is taken from Industrial Waste Profile No. 3: Paper Mills published by Federal Water Pollution Control Administration (November 1967).