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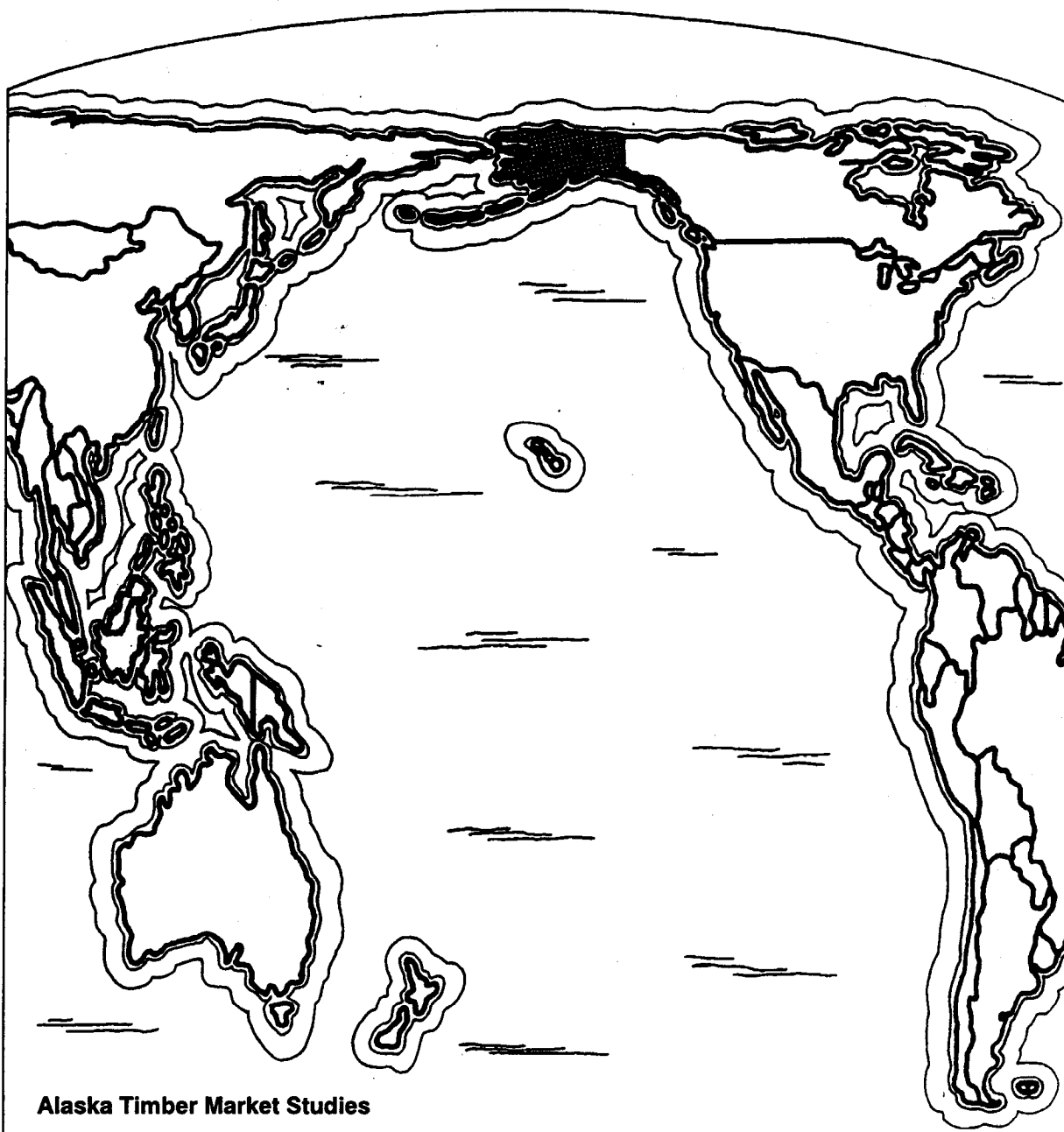
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Dissolving Pulp Industry Market Trends

Irene Durbak



Abstract

This report presents a worldwide overview of the dissolving pulp industry and highlights of this industry in Alaska. It describes trends in world markets and major end-use markets, with special emphasis on the manufacture and use of textile fibers in the United States. Figures and tables present data on production, consumption, and trade of dissolving pulp and the cellulosic fibers-rayon and acetate-produced from it. Data are also given on the production and use of competing natural and synthetic fibers, such as cotton, silk, nylon, and polyester.

Keywords: Dissolving pulp, market trends, Alaskan wood pulp, pulp exports, rayon, acetate, textile fibers

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Dissolving Pulp Industry

Market Trends

Irene Durbak, Research Forester
Forest Products Laboratory, Madison, Wisconsin

Introduction

This report discusses worldwide trends in capacity, production, consumption, trade, and end uses for the dissolving pulp industry. Trends and operating activity in the late 1980s at two Alaskan pulp mills are also given. Much of the information on the Alaskan mills was obtained through personal communication with mill representatives in 1989. The report begins with a brief description of dissolving pulp, including its processes and uses. This is followed by a discussion of the industry and trends for dissolving pulp in Alaska and worldwide. End-use markets of dissolving pulp are also discussed, with emphasis on the manufacture and use of textile fibers in the United States.

Processes and Uses

Dissolving wood pulp is a chemically refined bleached pulp composed of more than 90 percent pure cellulose fiber. This pulp has special properties, such as a high level of brightness and uniform molecular-weight distribution. It is used to make products that include rayon and acetate textile fibers, cellophane, photographic film, and various chemical additives (Hinck and others 1985) (Table 1). To a large extent, use of dissolving wood pulp depends on its purity (cellulose content), which depends mainly on the production process.

Two basic processes are used to produce dissolving pulp (Hielt 1985). The sulfite process produces (sulfite) pulp with a cellulose content up to 92 percent. It can use ammonium, calcium, magnesium or sodium as a base. The prehydrolysis sulfate process produces (sulfate) pulp with a cellulose content up to 96. Special alkaline purification treatments can yield even higher cellulose levels—up to 96 percent for the sulfite process and up to 98 percent for the sulfate process (Hielt 1985). The 90- to 92-percent cellulose-content sulfite pulps are used mostly to make viscose rayon for textiles and cellophane. The 96- to 98-percent cellulose-content sulfate pulps are used to make rayon yarn for industrial products such as tire cord, rayon staple for high-quality fabrics, and various acetate and other specialty products (Hielt 1985; Miller Freeman Publications, Inc. 1989b).

In Alaska, dissolving wood pulp is made from softwood fiber using a sulfite process with a magnesium base. This yields a pulp with a cellulose content of about 91 percent, and most of the pulp produced is of this grade.¹

Most producers worldwide make dissolving pulp using softwood fiber and the acid-sulfite and sulfate process (Tables 2 and 3). They tend to target similar end-use markets as do Alaskan producers. In the United States, almost half the production capacity in 1989 was in softwood sulfite pulp; in Canada, all the production capacity was in softwood sulfite pulp. Sulfite pulp produced in Japan, South Africa, and Spain is made from eucalyptus and other hardwood fiber.

Industry and Trends

Alaska

In 1988, two Alaskan pulp mills produced close to 355×10^3 t of wood pulp, consumed about $2 \times 10^6 \text{ m}^3$ (solid volume) of pulpwood logs and chips, and employed about 880 people (Forest Service 1989). (In this report, 1 t = 1 metric ton = 1.10 short tons.) These mills are the Alaska Pulp Corporation in Sitka and the Ketchikan Pulp Company in Ketchikan. In 1988, Alaska's dissolving pulp capacity was about 28 percent of the total U.S. capacity and 7 percent of the total world capacity. Alaska's capacity was greater than that of Canada by almost 30 percent.

Alaska produces dissolving wood pulp mostly for the rayon staple industry and small amounts of sulfite pulp for the paper industry. A large portion of this dissolving pulp is exported to the Pacific Rim, Europe, and Latin America; a small portion (10 to 20 percent) is shipped to U.S. domestic markets.

Since 1984, dissolving pulp exports from Alaska have increased, leveling off after 1988 (Fig. 1). In 1989, Alaskan pulp exports totaled 254.6×10^3 t, valued at US\$205.2 $\times 10^6$ 4). This was Alaska's highest export level in more than 10 years and was more than a third of the total U.S. dissolving pulp exports. In 1990, export volume and value decreased (Table 4).

¹Information obtained by the author during mill visit, May to June 1989.

In 1989, 40 percent of Alaska's dissolving pulp exports went to Japan, the main market for Alaskan pulp. Other major markets included Taiwan, China, and India (Fig. 2).

Trends during the late 1980s indicated a strong market position for Alaskan dissolving pulp. As the volume and value of Alaskan dissolving pulp exports increased dramatically, production was pushed to near capacity levels. Helped by demand for paper-grade pulps and their increasing prices, market prices for dissolving pulp in domestic and foreign markets increased as well (Table 5). Production incentives at the Sitka and Ketchikan mills were targeted at increasing production levels to meet the strong demand.¹ In 1990, prices started decreasing, however.

Trends in Alaskan dissolving pulp exports to individual markets reflected worldwide trends in dissolving pulp production, consumption, and trade. After 1985, exports to Japan increased for a few years after decreasing in the early 1980s (Table 6). Alaska's share of Japanese imports increased also, but not to the levels of previous years, reflecting increased Japanese imports from other sources (Fig. 3). Exports to other markets, like Western Europe, Eastern Europe, and Taiwan, gained in relative importance (Table 7). Increasing exports to Western Europe and Japan reflect, in part, decreasing production capacity in these markets. Increasing exports to other markets reflect a growing trend in consumption.

During the late 1980s, the Alaska Pulp Corporation and the Ketchikan Pulp Company improved the efficiency of their dissolving pulp operations.¹ Labor costs decreased and productivity increased. Using magnesium as a base for their sulfite process enabled them to achieve high levels of chemical recovery. Their use of purchased fuel oil also decreased. At the Alaska Pulp Corporation, recovered methane substituted for some of their fuel oil needs. At the Ketchikan Pulp Company, most of the needed energy came from recovered red liquor and hogged fuel. The latter mill was building a strong market base with a wide range of customers. Both mills were striving to maximize returns on their wood raw material by increasing mill production and by using sawmill residues in pulp production. In addition, both mills were taking advantage of increased profitability to invest in treatment facilities to meet environmental standards.²

Worldwide

In 1988, total world capacity for dissolving pulp production was 5.1×10^6 t (Table 8). This was a sharp decrease from previous years, when total capacity was about 6×10^6 t. The decrease was due mainly to a large decrease in capacity in the former U.S.S.R. where some mills closed

²It has been announced that one dissolving pulp mill in Alaska will be suspending pulping operations permanently as of September 30, 1993.

for environmental reasons (Miller Freeman Publications, Inc. 1989b). In 1990, world capacity dropped further to 4.9×10^6 t, mainly because of a decrease in Eastern Europe (Table 8).

In 1987, the former U.S.S.R. had the highest reported dissolving pulp capacity at 1.7×10^6 t or 29 percent of the world total (Table 8). In 1988, reported capacity in the former U.S.S.R. decreased sharply to 760×10^3 t or 15 percent of the world total. In 1990, however, capacity started to recover. In 1990, United States capacity was 1.4×10^6 t or 28 percent of the total world dissolving pulp capacity (Fig. 4).

In general, total world capacity for dissolving pulp production has been decreasing, especially since 1985 (Fig. 5, Table 8). This reflects lower profitability for dissolving pulp producers as a result of increasing costs, decreasing prices, and competition from synthetic fibers (Miller Freeman Publications, Inc., 1988e).

During the early 1980s, eight mills in Western Europe either closed or converted to paper pulp production. As a result, dissolving pulp capacity in Western Europe decreased. It then rebounded somewhat in 1990 (Table 8). Two Canadian mills and one Japanese mill closed, and capacity in the United States, Canada, and Japan also decreased. Capacity also decreased in Eastern Europe, especially in 1990. In contrast, capacity increased in India, South Africa, and Latin America.

The trend in world production of dissolving pulp has gradually decreased since 1970. This trend parallels a general decrease in total world consumption (Fig. 5). Both production and consumption decreased in the United States, Japan, and Western Europe (Tables 9 and 10). However, production increased in the former U.S.S.R. (until 1987), South Africa, and India.

Between 1982 and 1987, total world production of dissolving pulp increased somewhat (Fig. 5). This mirrors the production trend in the United States since 1982 (Fig. 6). With domestic consumption at a relatively constant level since 1982, U.S. exports increased (Fig. 7, Table 11).

From 1970 to 1986, Japanese production and consumption of dissolving pulp decreased, with production decreasing more than consumption. This gap increased imports (Fig. 8). Since 1986, imports have been decreasing.

A similar gap existed in Western Europe, especially during the early 1980s when dissolving pulp production decreased sharply. This may partly account for Western Europe's increased imports from Alaska and other sources during that time (Table 6 and 12).

During the 1970s, consumption of dissolving pulp in Eastern Europe (including the former U.S.S.R.) increased

sharply (Fig. 7). Since 1975, Eastern Europe has been the largest consumer of dissolving pulp. Consumption, like production, increased more slowly during the 1980s. In 1988, production decreased sharply as a result of plant closings (Fig. 6).

During the 1970s and 1980s, dissolving pulp production, consumption, and capacity in India increased steadily and the gap between production and apparent consumption narrowed (Figs. 6 and 7; Tables 8-10).

Of particular relevance to dissolving pulp producers in the Pacific Northwest is the production increase in South Africa since 1970. One South African mill produces hardwood sulfite pulp mainly for viscose rayon staple production. With low production costs, the mill has been a strong market competitor in southeast Asia, helping prices decrease in the early 1980s (Miller Freeman Publications, Inc. 1988a). In addition, foreign currency exchange rates during the 1980s were favorable for South African exporters to Japan; the rand depreciated much more against the Japanese yen than did U.S. and Canadian currencies (Stevens and Adams 1991). In 1987, South Africa supplied an estimated 14 percent of total world dissolving pulp exports; in 1990, South Africa supplied 22 percent of total world exports (Table 11).

End-Use

About 77 percent of all dissolving pulp is used in the manufacture of cellulosic fibers (rayon and acetate) (Table 1). These include (a) viscose rayon staple and filament yarn used mainly for textiles, tire cords, and various industrial products and (b) acetate staple and filament yarn used for textiles and acetate fiber (tow) for cigarette filters.

Since the 1960s, world fiber competition has increased as a result of various synthetic (noncellulosic, manufactured) fibers including nylon, polyester, acrylic, olefin, and glass fiber (Fig. 9). These fibers have been gaining a sharply increasing share of the total market for manufactured fibers. As a result, production and consumption of cellulosic (manufactured rayon and acetate) fibers made from dissolving pulp gradually decreased.

Natural (nonmanufactured) fibers, especially cotton, have consistently dominated the textile fiber market worldwide. Production and consumption increased steadily, especially since the mid-1970s (Fig. 9).

In 1988, total world production of textile fibers was 37.2×10^6 t (Fig. 10). More than half the total production consisted of natural fibers: cotton (49 percent), wool (15 percent), and silk (1 percent). Synthetic fibers were 38 percent of the total, and cellulosic fibers (rayon and acetate) were less than 8 percent. During the 1980s, the proportion of synthetic fibers increased, and the proportion of wool and cellulosic fibers decreased.

The increase in synthetic fibers relative to cellulosic fibers is also evident when considering the change in the number of fiber-producing facilities worldwide. Although the total number of fiber-producing facilities increased only 3 percent between 1972 and 1988, the number of polyester-producing facilities increased 50 percent (Fig. 11). The number of rayon-producing facilities decreased 67 percent; acetate-producing facilities decreased 57 percent.

The largest decrease in fiber-producing facilities occurred in Western Europe. In 1988, Western Europe had 27 rayon and acetate plants compared to 72 in 1972 (Fig. 12). Moreover, production of rayon and acetate in Western Europe decreased sharply during the 1970s and early 1980s (Fig. 13a). This parallels the decrease in dissolving pulp production and consumption discussed previously. In 1988, Western Europe produced 18 percent of the world's rayon and acetate fiber (Fig. 14).

The former U.S.S.R. has been the largest producer of rayon and acetate (Fig. 14). In 1988, the former U.S.S.R. produced 21 percent of the world total. In 1990, however, production dropped to 0.84×10^6 t; this was 20 percent of the world total (Fiber Organon 1992a-c). In Eastern Europe, including the former U.S.S.R., the trend in rayon and acetate production remained relatively constant throughout most of the 1970s and 1980s at 1.0 to 1.5×10^6 t (Fig. 13a).

Japan is a net exporter of rayon and acetate fiber. In 1988 and 1990, Japan produced 10 percent of the world total and consumed only 6 percent of the world total (Fig. 14) (Fiber Organon 1992c). The trend in production of rayon and acetate was somewhat level during the early 1980s, then decreased gradually after 1985 (Fig. 13a). This paralleled the trend in consumption of dissolving pulp in Japan.

Production of rayon and acetate in the People's Republic of China and Taiwan increased steadily throughout the 1970s and 1980s (Fig. 13b). Production in India decreased in 1982 but then recovered and continued its steady increase during the rest of the 1980s. As previously mentioned, consumption of dissolving pulp in India increased steadily throughout the 1970s and 1980s.

United States production of cellulosic textile fiber (excluding acetate fiber for cigarette filters) has gradually decreased, similar to the trend in Western Europe. Production decreased sharply during the major recession years, then maintained the new lower levels in the following years (Fig. 15). Since 1982, rayon and acetate production has remained at about 0.3×10^6 t, decreasing to 0.2×10^6 t in 1990 (Fiber Organon 1993). In contrast, U.S. production and consumption of synthetic fibers have increased sharply, especially during the early 1970s (Fig. 15).

Most fiber used in the United States is synthetic (polyester, nylon, acrylic, glass); this is followed by cotton. In 1990, synthetic fibers were 61 percent of total U.S. fiber

consumption; cotton and wool were 35 percent; rayon and acetate fibers were only 4 percent of total fiber consumption (Fig. 16). Compared to 1990, market share for cotton increased, while that for synthetic and cellulosic fibers decreased.

In 1990, total U.S. consumption of rayon and acetate textile fiber was 0.27×10^6 t (excludes acetate fiber used for cigarette filter). In 1980, total U.S. consumption was 0.34×10^6 . The hugest use (49 percent) was in textiles, for apparel production (Fig. 17). Other major uses of textile fiber included fabric for drapery and upholstery (15 percent), filament yarn for various industrial products including tire cords (21 percent), medical and sanitary products (13 percent), and other home textiles (2 percent) (Fiber Organon 1992a-c).

Use of synthetic fibers, mainly polyester, nylon, and acrylic predominated in the U.S. apparel industry during the 1970s and early 1980s (Fig. 18). Use of cotton, which was second in importance in the apparel industry, has increased dramatically since 1982, surpassing synthetic fibers in the late 1980s. In 1990, use of cotton dominated.

Use of cellulosic fiber, mainly rayon, slowly decreased during the 1970s. Since 1985, however, use of rayon has experienced a gradual increase. The increase reflects, in part, the popularity of high-quality rayon fabric developed in the late 1980s.

Use of synthetic fiber predominates in the drapery and upholstery industry. Use of synthetic fiber and cotton increased sharply since 1982 (Fig. 19). Use of rayon, which was as important as cotton in the late 1970s, decreased sharply during the late 1970s as did use of cotton. Unlike cotton, use of rayon did not recover much after 1982.

The high absorbency of rayon makes it a valuable fiber for various medical and sanitary products, such as gauzes, cotton balls, tampons, and diapers (Randel). However, use of rayon decreased and use of synthetic fibers increased (Fig. 20).

Rayon and acetate fibers are also used in a wide range of industrial and miscellaneous consumer products, such as hoses, belting, felts, fiberfill, cordage, paper and tape reinforcing, and tires (Textile Economics Bureau 1989f). Although low in comparison to cotton and synthetic fibers,

use of rayon and acetate fiber remained relatively constant during the 1980s (Fig. 21).

Use of high-tenacity rayon yarn for tire cord and cord fabric decreased sharply in the United States during the early 1970s, and use of polyester fiber predominated (Fig. 22). Since 1975, use of rayon decreased more gradually, use of polyester and nylon decreased sharply, and use of steel increased sharply. In 1990, use of rayon for tires and tire cord was only 3 percent of total U.S. consumption of rayon and acetate fiber. In 1990, that use dropped to less than 1 percent (Fig. 17).

Conclusions

Long-term trends in production and consumption of dissolving pulp have been slowly decreasing as competing natural and synthetic fibers have been increasing their share of end-use markets. During the late 1980s, a leveling occurred in the long-term trends for dissolving pulp, with overall stable levels of production and consumption. In some world markets and end-use products, consumption of dissolving pulp increased. Some producers making sulfite pulp from inexpensive hardwood fiber may be better able to compete with Alaskan producers in certain markets.

For several years during the late 1980s, with worldwide decreases in production capacity and favorable currency exchange rates for U.S. exporters, Alaskan producers experienced increasing export volumes and increasing prices. The decrease of the U.S. dollar relative to the Japanese yen and other major currencies was an important factor favoring U.S. exports. A stable weak-dollar position could help support the cost-competitiveness of U.S. wood pulp in foreign markets having stronger currencies. As Stevens and Adams (1991) point out, some currencies have depreciated greatly against the Japanese yen, for example, the South African rand. This could have affected the quantity of Japanese dissolving pulp imports from South Africa.

In 1989, internal investments and efforts aimed at decreasing costs and improving operating efficiency and marketing effectiveness were seen as helping to place dissolving pulp producers in Alaska in a better position to compete when market trends became less favorable. It appeared that if producers could continue to supply a high-quality product at a low cost relative to competing supplies, then these producers would be able to compete effectively and maintain a strong niche in a shrinking world market.

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Table 1—Derivatives and end-use products from dissolving pulp^a

Derivative	End-use product	Total pulp use (percent)
Cellulosic fibers		
Viscose rayon staple		
Regular	Apparel fabric	42
High-wet modulus	Special fabric for apparel, furnishings	3
Viscose rayon filament yam		
Regular tenacity	Apparel	10
High tenacity	Tire cord and belting, industrial uses	7
Acetate staple and tow	Cigarette filters	8
Acetate filament yam	Apparel, furnishings	7
Others		
From viscose rayon		
Cellophane	Packaging	7
Sponges, sausage casings		1
Acetate plastics	Photographic films, sheets, moldings	1
Cellulose nitrates	Lacquers, film, explosives	8
Other cellulosic organic compounds	Additives in food, cosmetics	8
Special paper pulps	Filter, photographic papers	2

^aSource: Hiett 1985; Hinck and others 1985.

Table 2—Producers of sulfite dissolving pulp, excluding East European producers^a

Country and producer	Wood type	Annual capacity (x10 ³ t)
United States		
Alaska Pulp Corporation (Alaska)	Softwood	175
ITT Rayonier (Florida)	Softwood	150
ITT Rayonier (Washington)	Softwood	155
Ketchikan Pulp Company (Alaska)	Softwood	182
Weyerhaeuser Company (Washington)	Softwood	65
Canada		
Tembec Forest Prod. (Quebec)	Softwood	160
Western Pulp Ltd. (B.C.)	Softwood	167
Finland		
Rauma-Repola/Rauma Pulp	Softwood	180
Federal Republic of Germany ^b (former West Germany)		
Bayerische Zellstoff	Softwood	60
Schwabische Zellstoff	Softwood	95
	Hardwood	
Italy		
Chimica del Friuli	Hardwood	50
Norway		
Borregaard Industries	Softwood	170
Saugbrugsforeningen	Not available	70
Spain		
SNIACE	Eucalyptus	75
India		
South India Viscose Ltd.	Not available	42
Japan		
Jufo Pulp Company	Not available	135
Kohjin Pulp Company	Hardwood	70
Sanyo-Kokusaku Pulp Company	Hardwood	120
South Africa		
Saiccor	Hardwood	450

^aSource: Miller Freeman Publications, Inc. 1988a,c; 1991.
Forest Service 1989.

^bWest Germany, prior to reunification in October 1990.

**Table 3—Producers of sulfate dissolving pulp,
excluding East European producers^a**

Country and producer	Wood type	Annual capacity (x10 ³ t)
United States		
Buckeye Cellulose (Florida)	Softwood	180
International Paper (Mississippi)	Hardwood	220
ITT Rayonier (Georgia)	Softwood	350
Yugoslavia		
Viskoznih Proizvoda and Celuloze	Not available	48
India		
Gwalior Rayons	Hardwood	72
Harihar Polyfibres	Hardwood	58
Brazil		
Riocell	Hardwood	30

^aSource: Miller Freeman Publications, Inc. 1988c,d, 1991.

**Table 4—Quantity and value of dissolving pulp exports from the
Anchorage Customs District ^a**

Unit year	Quantity (x10 ³ t)	Value (x10 ⁶ US\$)	Unit value per metric ton (US\$)	1980 unit value metric ton (US\$) ^b
1978	186.7	75.5	404	519
1979	228.6	109.6	479	547
1980	222.1	123.6	557	557
1981	224.0	124.9	558	511
1982	181.0	95.1	525	472
1983	216.4	114.7	530	470
1984	161.3	79.4	493	362
1985	175.2	72.8	416	362
1986	200.7	86.6	432	387
1987	230.0	118.7	516	451
1988	250.4	166.7	666	559
1989	254.7	205.5	807	646
1990	249.3	171.7	689	531

^aSource: Bureau of Census 1990.

^bCalculated using the producer price index (1980 = 100) reported by the U.S. Department of Labor, Bureau of Labor Statistics, and the U.S. Department of Commerce, Bureau of Economic Analysis.

Table 5—U.S. domestic prices for selected market pulps delivered^a

Year end	Bleached sulfite (US\$/t)	Bleached sulfate (Kraft, softwood (US\$/t))		Dissolving sulfite (US\$/t) ^b
		South United States	North United States	
1975	400	353	410	425
1976	400	353	410	468
1977	320	287	342	455
1978	358	353	375	430
1979	450	400	460	530
1980	520	507	530	670
1981	520	495	530/565	620
1982	420	365	440	530
1983	420/430	415/425	440	525
1984	455	475	510	530
1985	355	360	400	500
1986	470	490	480	510
1987	565/575	585	610	615/635
1988	730	735/740	760	800/810
1989	790	800	830	880/900
1990	690	620	765	730/750

^aSource: Miller Freeman Publications, Inc. 1987; 1988a,b,f; 1989a.

^bPurity - 91-92 alpha.

Table 6—Volume of Alaskan dissolving pulp exports by destination market^a

Year	Exports (x10 ³ t)									Total
	Pacific Rim				India/ Egypt	Western Europe ^c	Eastern Europe ^d	Former U.S.S.R.	Other ^e	
	Japan	Taiwan	China	Other ^b						
1978	103.3	14.5	7.2	14.2	44.7	0	1.0	0	1.8	186.7
1979	145.4	21.5	2.9	26.8	16.9	1.8	6.4	0	6.9	228.6
1980	150.3	16.5	22.5	10.5	11.9	0	2.2	0	8.1	222.0
1981	139.5	12.4	12.0	21.1	21.7	2.2	1.0	0.5	12.7	223.1
1982	94.5	7.3	14.5	26.0	17.5	8.4	1.5	0	10.7	180.4
1983	118.3	28.2	4.6	26.4	23.3	6.1	0	6.0	3.6	216.5
1984	80.7	18.1	18.6	11.2	29.6	2.0	0	0	1.0	161.2
1985	79.2	10.0	16.9	8.8	48.9	7.4	0	0	4.0	175.2
1986	89.8	30.9	24.5	9.5	25.8	8.0	1.2	7.9	3.0	200.6
1987	95.5	33.7	30.1	9.4	39.0	7.3	4.1	7.9	3.0	230.0
1988	108.0	48.1	24.7	5.9	29.3	9.3	9.4	12.0	3.0	250.4
1989	100.9	54.1	26.8	17.2	26.2	9.6	7.2	11.6	1.0	254.6
1990	84.0	41.2	24.5	11.6	59.0	9.3	11.0	8.7	—	249.3

^aSource: Bureau of the Census 1990.

^bIncludes Indonesia, South Korea, and Thailand.

^cIncludes Austria, Belgium, Luxembourg, Finland, France, Netherlands, Spain, and former West Germany.

^dIncludes Bulgaria, Czechoslovakia, Hungary, and Poland.

^eIncludes Argentina, Bangladesh, Canada, Iraq, and Venezuela.

Table 7—Alaskan dissolving pulp exports by destination market^a

Year	Total exports (%)									Total
	Pacific Rim				India/ Egypt	Western Europe ^c	Eastern Europe ^d	Former U.S.S.R.	Other ^e	
	Japan	Taiwan	China	Other ^b						
1978	55.3	7.8	3.9	7.6	23.9	0.0	0.5	0.0	1.0	100
1979	63.6	9.4	1.3	11.7	7.4	0.8	2.8	9.9	3.0	100
1980	67.7	7.4	10.1	4.7	5.4	0.0	1.0	0.0	3.6	100
1981	62.5	5.6	5.4	9.5	9.7	1.0	0.4	0.2	5.7	100
1982	52.4	4.0	8.0	14.4	9.7	4.6	0.8	0.0	5.9	100
1983	54.6	13.0	2.1	12.2	10.8	2.8	0.0	2.6	1.7	100
1984	50.1	11.2	11.5	6.9	18.4	1.2	0.0	0.0	0.6	100
1985	45.2	5.7	9.6	5.0	27.9	4.2	0.0	0.0	2.3	100
1986	44.8	15.4	12.2	4.7	12.9	4.0	0.6	3.9	1.5	100
1987	41.5	14.7	13.1	4.1	17.0	3.2	1.8	3.4	1.3	100
1988	43.5	19.2	9.9	2.4	11.7	3.7	3.8	4.8	1.2	100
1989	39.6	21.2	10.5	6.8	10.3	3.8	2.8	4.6	0.4	100

^aSource: Bureau of the Census 1991.

^bIncludes Indonesia, South Korea, and Thailand.

^cIncludes Austria, Belgium, Luxembourg, Finland, France, Netherlands, Spain, and former West Germany.

^dIncludes Bulgaria, Czechoslovakia, Hungary, and Poland.

^eIncludes Argentina, Bangladesh, Canada, Iraq, and Venezuela.

Table 8—World capacity for dissolving pulp production^a

Year	Capacity (x10 ³ t)										Total
	United States	Canada	Other Western Europe ^b	Nordic countries ^c	Former U.S.S.R.	Eastern Europe ^d	Japan	South Africa	India	Other ^e	
1970	1575	490	728	755	600	379	596	220	60	88	5491
1971	1608	500	742	650	700	390	593	250	80	114	5627
1972	1609	428	659	670	850	390	598	250	80	217	5751
1973	1644	390	681	730	925	375	582	270	90	225	5912
1974	1650	404	715	710	1000	415	521	280	120	229	6044
1975	1618	397	727	685	1025	419	479	280	120	214	5964
1976	1481	393	673	665	1100	411	479	310	120	114	5746
1977	1425	343	675	660	1175	402	479	310	120	114	5703
1978	1487	424	688	690	1250	472	479	313	130	116	6049
1979	1393	395	698	655	1325	496	479	317	150	104	6012
1980	1432	340	687	600	1400	542	479	325	176	99	6080
1981	1442	303	578	555	1475	535	449	363	135	116	5951
1982	1403	305	562	560	1550	530	449	400	135	117	6011
1983	1455	201	538	580	1625	532	449	440	175	108	6103
1984	1364	221	499	555	1700	519	449	485	175	127	6094
1985	1309	266	480	750	1700	519	449	412	200	146	6231
1986	1273	245	415	640	1700	519	345	415	220	156	5928
1987	1254	245	453	565	1700	519	325	415	250	189	5915
1988	1271	277	465	675	760	519	325	420	250	183	5145
1989	1357	281	458	720	760	522	325	420	250	183	5275
1990	1383	247	518	475	780	277	325	420	250	183	4858

^aSource: United Nations, FAO; 1984,1985,1988,1988,1989,1990,1991,1992b.

^bOther Western Europe include Austria, France, Spain, West Germany, and Yugoslavia.

^cNordic countries include Finland, Norway, and Sweden.

^dEastern Europe includes Bulgaria, Czechoslovakia, East Germany, Poland, and Romania.

^eOther includes Algeria, Argentina, Bangladesh, Brazil, China, and Turkey, Pakistan (in 1970-1971), Mexico, and Cuba (1,000 t in 1970).

Table 9—World production of dissolving pulp^a

Year	Production (x10 ³ t)										Total
	United States	Canada	Nordic countries ^b	Western Europe ^c	Former U.S.S.R.	Eastern Europe ^d	Japan	South Africa	India/Turkey	Other ^e	
1970	1547	414	695	603	542	354	554	217	— ^f	4	4930
1971	1518	391	627	535	639	354	545	239	49	5	4902
1972	1503	370	686	582	716	336	514	245	86	1	5018
1973	1485	293	671	602	739	36	489	258	96	1	5001
1974	1583	333	717	639	740	389	444	360	125	107	5417
1975	1436	226	606	503	800	372	280	419	121	65	4828
1976	1309	222	549	551	794	382	324	328	136	73	4668
1977	1271	268	504	592	800	399	330	348	139	52	4703
1978	1284	351	529	589	810	388	321	405	142	51	4870
1979	1360	368	513	576	753	345	316	420	152	47	4850
1980	1368	313	452	507	828	327	300	420	153	89	4757
1981	1239	274	433	561	782	345	256	420	154	77	4541
1982	991	220	401	459	796	348	266	386	152	70	4089
1983	1144	217	419	454	846	331	260	369	184	47	4271
1984	1094	221	430	463	872	316	252	406	184	67	4305
1985	1068	222	311	444	895	321	249	581	209	64	4364
1986	1141	222	247	440	895	325	172	581	209	66	4298
1987	1190	242	282	429	895	319	175	581	259	79	4451
1988	1240	266	454	307	692	321	177	581	259	87	4384
1989	1293	273	472	348	668	339	189	390	259	82	4313
1990	1173	221	444	294	668	332	187	400	259	93	4071

^aSource: United Nations, FAO; 1983,1988,1989,1992a.

^bIncludes Finland, Norway, and Sweden.

^cAustria, France, Spain, former West Germany, Italy, and Yugoslavia.

^dIncludes Bulgaria, Czechoslovakia, former East Germany, Poland, and Romania.

^eIncludes Argentina, Mexico, and Brazil (mostly Brazil).

^f—, negligible.

Table 10—World consumption of dissolving pulp^a

Year	Consumption (x10 ³ t)										World total
	United States	Canada	Japan	Nordic countries ^b	Other Western Europe ^c	Former U.S.S.R.	Eastern Europe ^d	India	Latin America	South Africa/Turkey/other ^e	
1970	1009	119	740	103	1392	542	413	23	96	57	4494
1971	1087	90	726	107	1230	640	416	63	85	75	4519
1972	988	98	734	173	1247	716	399	99	72	95	4622
1973	979	101	682	84	1332	739	451	104	65	86	4624
1974	1053	99	707	190	1267	740	505	124	184	88	4958
1975	935	135	456	263	1058	760	553	129	127	58	4453
1976	819	103	519	145	1076	794	524	134	126	130	4371
1977	713	174	534	76	1158	800	523	158	91	110	4337
1978	768	228	532	109	1010	810	428	170	88	178	4390
1979	841	182	569	72	1054	753	382	216	75	333	4556
1980	908	132	580	97	1028	761	442	216	116	326	4604
1981	754	113	464	82	1009	782	361	156	93	306	4115
1982	587	98	435	136	950	796	357	164	89	274	3869
1983	732	94	506	118	912	846	342	196	71	235	4053
1984	700	95	513	163	867	872	330	196	91	362	4189
1985	655	96	506	54	925	895	334	221	83	529	4291
1986	727	54	453	44	916	895	338	221	89	420	4254
1987	688	67	430	68	1038	895	335	271	99	494	4385
1988	680	60	436	72	692	692	336	271	110	564	3913
1989	792	72	430	47	739	668	354	271	104	382	3858
1990	665	—	409	142	672	668	341	271	115	344	3627

^aSource: United Nations, FAO; 1983,1988,1989,1992a.

^bIncludes Finland, Norway, and Sweden.

^cIncludes Austria, Belgium, Luxembourg, France, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Switzerland, United Kingdom, former West Germany, and Yugoslavia (93,000 metric tons in 1989 and 1990, estimate).

^dIncludes Czechoslovakia, former East Germany (170,000 metric tons, estimate, 1989–1990), Hungary, Poland, and Romania.

^eIncludes Australia, China, Indonesia, New Zealand, Pakistan, Philippines, South Korea, Turkey, Greece, and Thailand.

Table 11—World export volume of dissolving pulp^a

Year	Exports (x10 ³ t)							Total
	United States	Canada	South Africa	Nordic countries ^b	Former West Germany	Other Western Europe ^c	Other ^d	
1970	789	302	204	594	17	34	12	1952
1971	717	311	227	524	22	41	22	1864
1972	720	283	241	517	26	75	14	1876
1973	668	208	251	596	31	67	7	1828
1974	715	243	360	531	27	79	18	1973
1975	631	126	419	350	11	37	14	1588
1976	663	147	328	412	35	51	4	1640
1977	722	130	348	429	29	38	8	1704
1978	687	210	338	430	27	50	4	1746
1979	694	248	214	450	32	70	4	1712
1980	698	235	237	388	33	55	1	1647
1981	711	221	236	387	37	31	2	1625
1982	573	174	233	325	31	29	8	1373
1983	587	177	252	341	28	32	5	1422
1984	540	182	205	313	54	34	11	1339
1985	572	174	205	318	33	24	38	1334
1986	645	216	205	262	43	24	7	1401
1987	681 ^e	213	205	274	80	31	24	1462
1988	785 ^e	219	205	295	57	36	5	1601
1989	759 ^e	224	350	287	57	34	3	1716
1990	709 ^e	242	350	207	53	35	4	1599

^aSource: Bureau of the Census 1991. United Nations, FAO: 1983, 1988, 1989, 1992.

^bincludes Finland, Norway, and Sweden.

^cIncludes Belgium, Luxembourg, France, Italy, Netherlands, Portugal, Spain, United Kingdom, and Yugoslavia.

^dIncludes Hungary and Japan.

^eOf total U.S. exports, Alaska comprised 33.8 percent in 1987, 31.9 percent in 1988, 33.6 percent in 1989, and 35.2 percent in 1990.

Table 12—World import volume of dissolving pulp^a

Year	Imports (x10 ³ t)											World total
	United States	Canada	Pacific Rim			United Kingdom	Former West Germany	Other Western Europe ^c	Eastern Europe ^d	India	Other ^e	
			Japan	China	Other ^b							
1970	251	7	186	3	12	371	140	331	71	23	121	1516
1971	286	10	183	21	12	341	119	302	73	14	120	1481
1972	205	11	221	21	11	401	109	281	77	14	129	1480
1973	162	16	194	16	12	422	117	299	89	19	105	1451
1974	205	9	278	18	14	369	115	254	119	14	119	1514
1975	130	35	186	19	10	291	83	236		23	74	1213
1976	173	28	196	18	31	278	100	242	144	8	125	1343
1977	164	36	211	13	38	332	86	216	125	31	86	1338
1978	171	87	214	30	62	289	105	193	41	31	43	1346
1979	175	62	256	23	86	338	107	223	38	73	37	1418
1980	238	54	281	30	79	281	111	248	48	73	51	1494
1981	226	60	209	28	68	213	106	231	17	13	28	1199
1982	169	52	172	47	42	224	123	247	15	21	41	1153
1983	175	54	248	64	25	201	134	224	14	21	44	1204
1984	146	56	270	84	55	192	129	217	17	21	36	1223
1985	159	48	262	61	65	162	160	268	16	21	37	1259
1986	231	48	282	60	66	160	155	282	19	21	35	1359
1987	179	38	256	58	44	303	155	300	19	21	27	1400
1988	225	13	261	82	93	—	173	217	18	21	27	1130
1989	258	22	241	139	109	—	197	226	18	21	30	1261
1990	201	15	223	130	146	—	182	189	18	21	30	1155

^aSource: United Nations, FAO; 1983, 1988, 1989, 1992a.

^bincludes indonesia, Philippines, South Korea, and Thailand.

^cIncludes Belgium, Luxembourg, France, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden Switzerland, and

^dIncludes Czechoslovakia, fomer East Germany, and Hungary.

^eIncludes Australia, New Zealand, Pakistan, Cuba, Mexico, Argentina, Brazil, Colombia, Ecuador, Turkey, and south Africa.

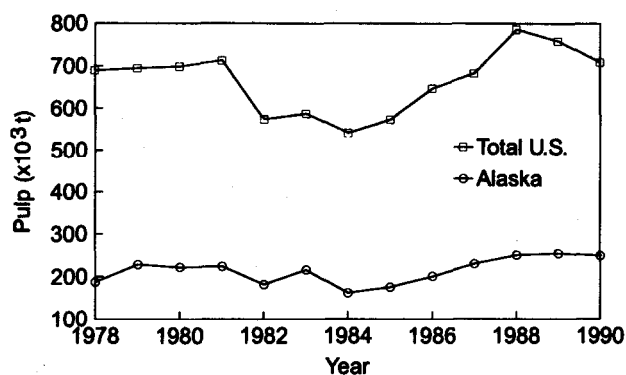


Figure 1—U.S. exports of dissolving pulp (Bureau of the census 1990).

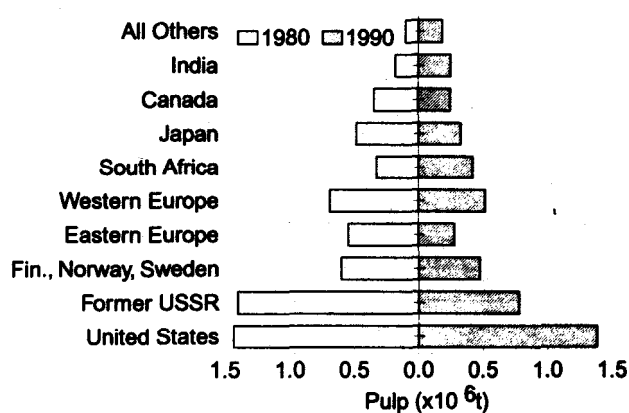


Figure 4—World distribution of dissolving pulp. Total 1980 capacity: 6.1×10^6 t. Total 1990 capacity: 4.9×10^6 t (United Nations, FAO 1984–1991).

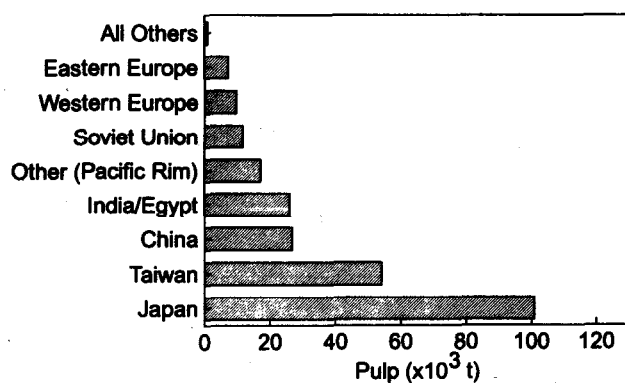


Figure 2—Distribution of 1989 Alaskan dissolving pulp exports. Total 1989 exports: 254.6×10^3 t (Bureau of the Census 1990).

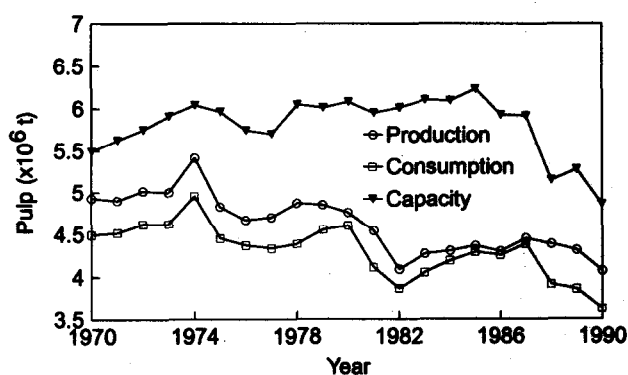


Figure 5—World trends in production, consumption, and capacity of dissolving pulp (United Nations, FAO 1983, 1984–1991, 1992a).

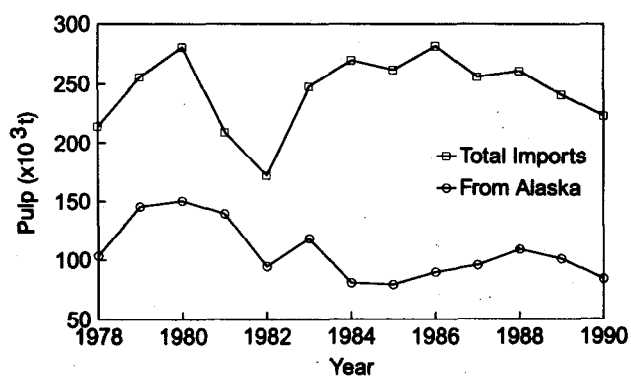


Figure 3—Japanese imports of dissolving pulp (Bureau of the Census 1990; United Nations, FAO 1983, 1992a).

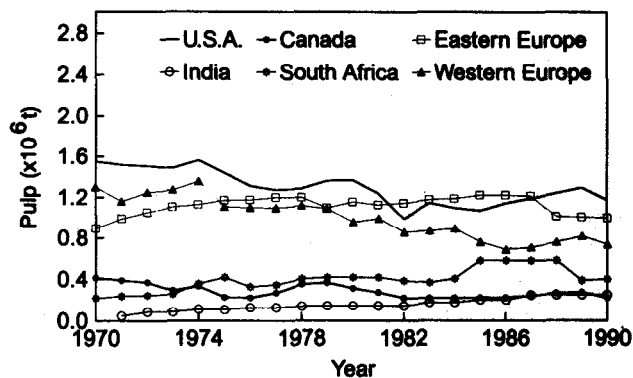


Figure 6—World trends in production of dissolving pulp. Eastern Europe includes former U.S.S.R.; Western Europe includes Norway, Sweden, Finland (United Nations, FAO 1983, 1992a).

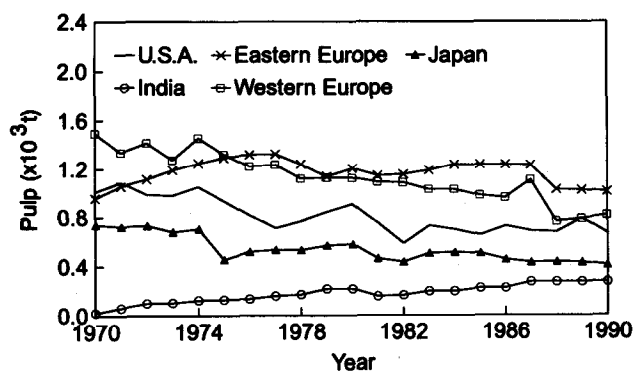


Figure 7—World trends in consumption of dissolving pulp (United Nations, FAO 1983, 1992a).

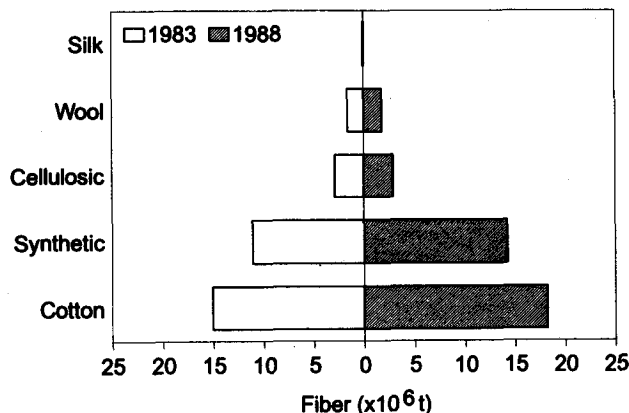


Figure 10—World production of textile fibers by type of fiber. Total 1983 production: 30.8×10^6 t. Total 1988 production: 37.2×10^6 t (Textile Economics Bureau 1984, 1989d).

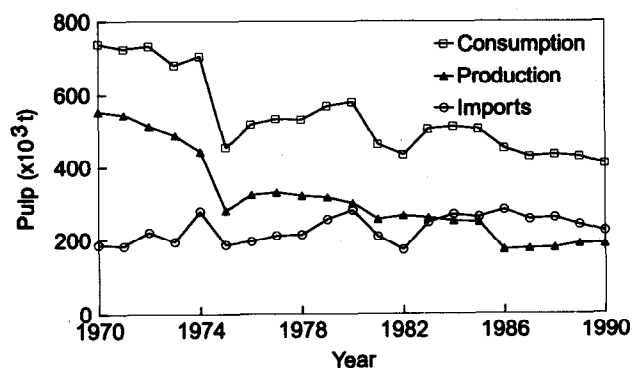


Figure 8—Japanese consumption, production, and imports of dissolving wood pulp (United Nations, FAO 1983, 1992a).

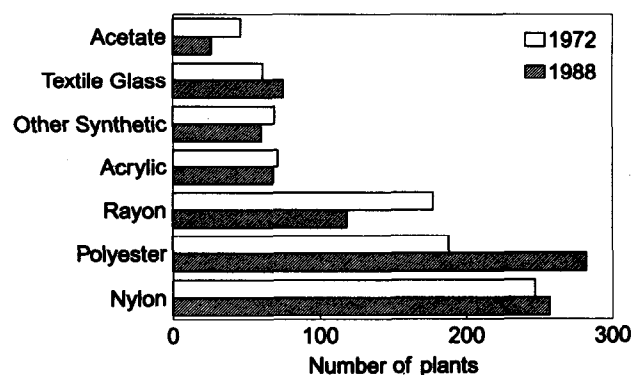


Figure 11—Number of world fiber-producing plants by type of fiber. 1972 total plants: 859; 1988 total plants: 886 (Textile Economics Bureau 1973b, 1989c).

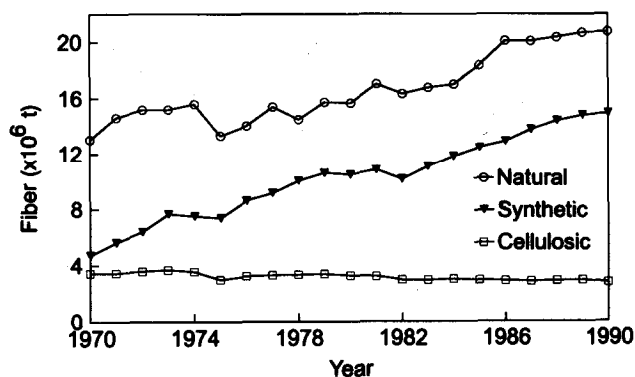


Figure 9—World trends in fiber production by type of fiber. Cellulosic fibers include textile rayon and acetate; synthetic fibers include nylon, polyester, acrylic, and other synthetic fibers; natural fibers include cotton, wool, and silk (Fiber Organon 1992b; Textile Economics Bureau 1973c, 1979b, 1984, 1989d).

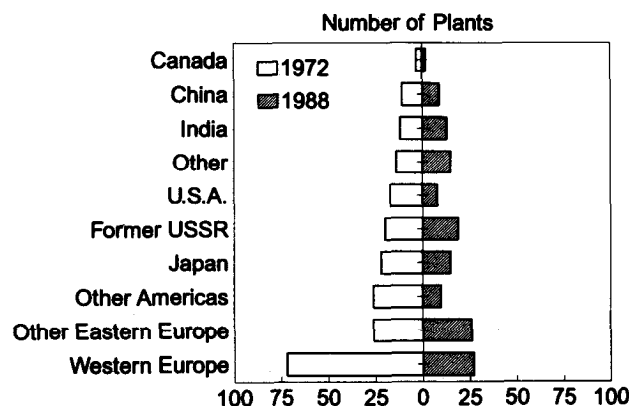


Figure 12—World distribution of rayon and acetate fiber. 1972 total rayon and acetate plants: 223; 1988 total rayon and acetate plants: 144 (Textile Economics Bureau 1973b, 1989c).

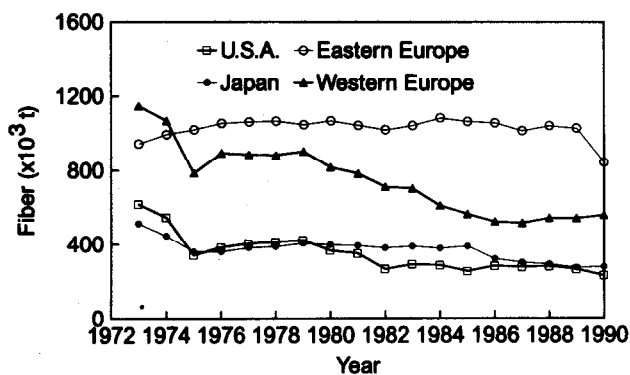


Figure 13a—World production of rayon and acetate fiber. Eastern Europe includes former U.S.S.R.; Western Europe includes Norway, Sweden, Finland (Fiber Organon 1992b; Textile Economics Bureau 1980a, 1986a, 1989e).

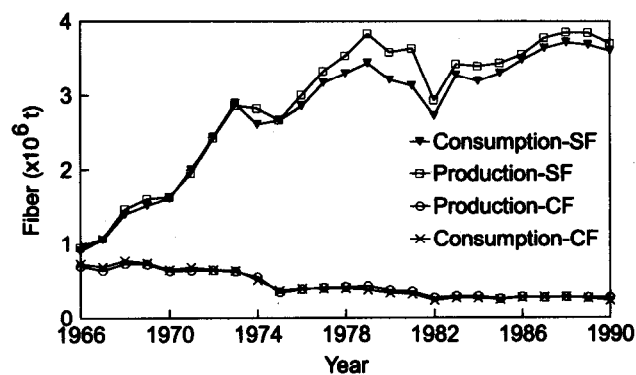


Figure 15—U.S. production and mill consumption of synthetic and cellulosic fiber. Cellulosic fibers (CF) include textile rayon and acetate; synthetic fibers (SF) include nylon, polyester, acrylic, and other synthetic fibers (Fiber Organon 1992b, 1993; Textile Economics Bureau 1989b,g).

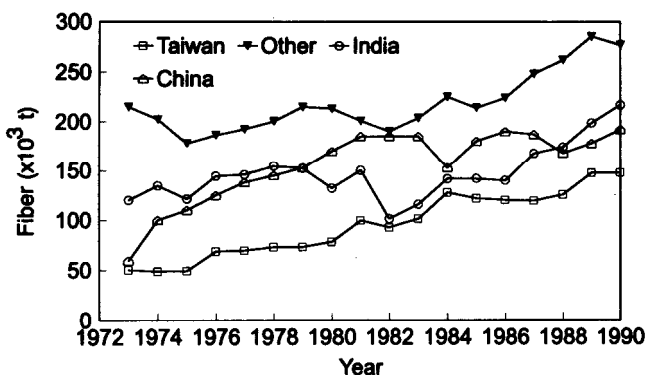


Figure 13b—World production of rayon and acetate. Other includes Latin America and Canada (Textile Economics Bureau 1980a, 1986a, 1989e).

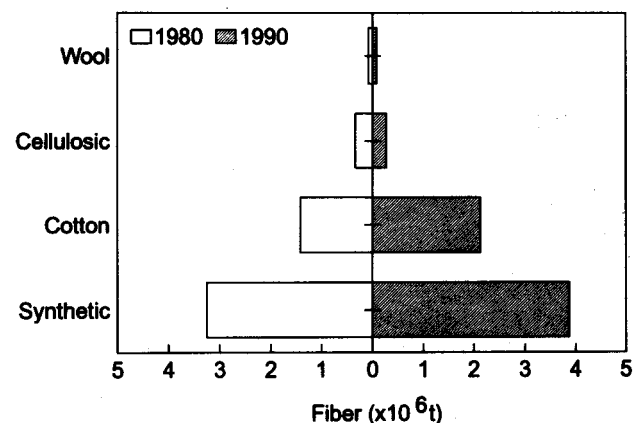


Figure 16—U.S. mill consumption of textile fibers. Total 1980 consumption: 5.1×10^6 t; total 1990 consumption: 6.4×10^6 t. Cellulosic fibers include textile rayon and acetate; synthetic fibers include nylon, polyester, acrylic, and other synthetic fibers. (Consumption equals production plus imports less exports.) (Fiber Organon 1992a; Textile Economics Bureau 1989b).

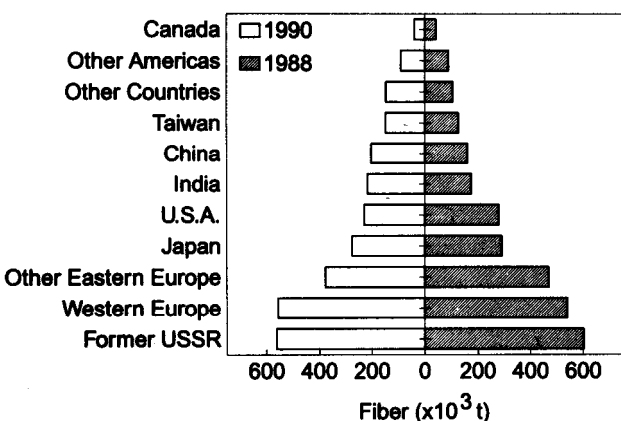


Figure 14—World production of rayon and acetate fiber. Total 1990 production: 2.8×10^6 t (Fiber Organon 1992c; Textile Economics Bureau 1990).

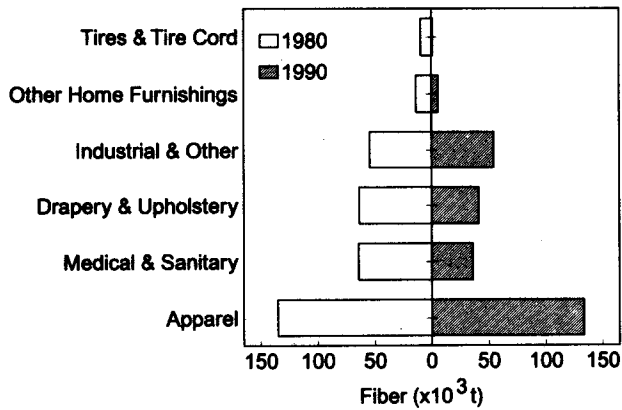


Figure 17—U.S. consumption of rayon and acetate fiber by type of end product. Total 1980 consumption: 340×10^3 t; total 1990 consumption: 272×10^3 t. (In 1988, rayon used in tire production was less than 1 percent of total U.S. consumption.) (Fiber Organon 1992a; Textile Economics Bureau 1989f).

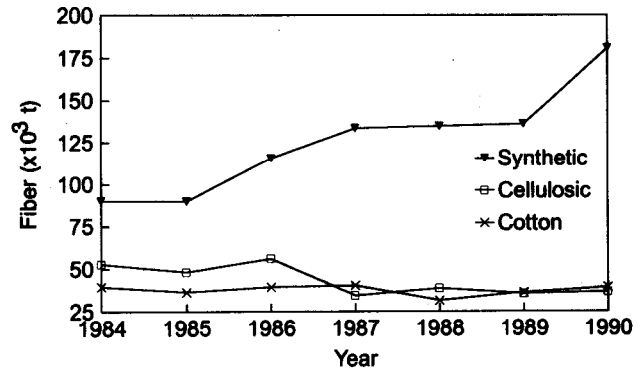


Figure 20—Fiber consumed in U.S. production of medical and sanitary products. Cellulosic fibers include textile rayon and acetate; synthetic fibers include nylon, polyester, acrylic, and other synthetic fibers (Fiber Organon 1992a; Textile Economics Bureau 1989f).

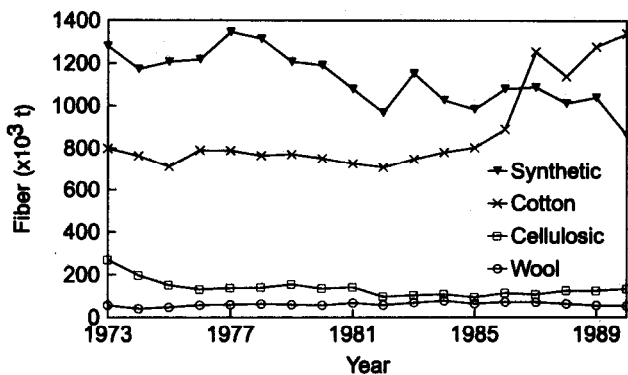


Figure 18—Fiber consumed in U.S. production of apparel (Fiber Organon 1992a; Textile Economics Bureau 1980b, 1985, 1989f).

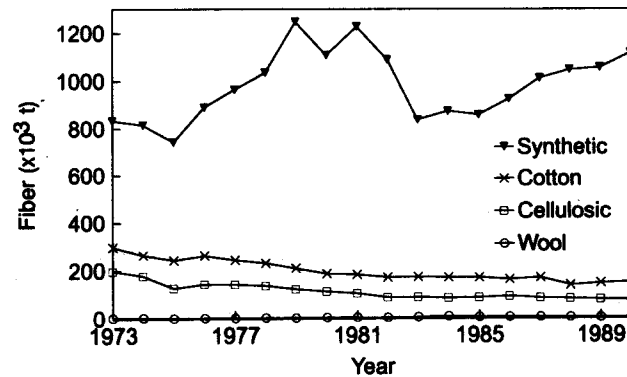


Figure 21—Fiber consumed in U.S. industrial and other consumer-type products (Fiber Organon 1992a; Textile Economics Bureau 1980b, 1985, 1989f).

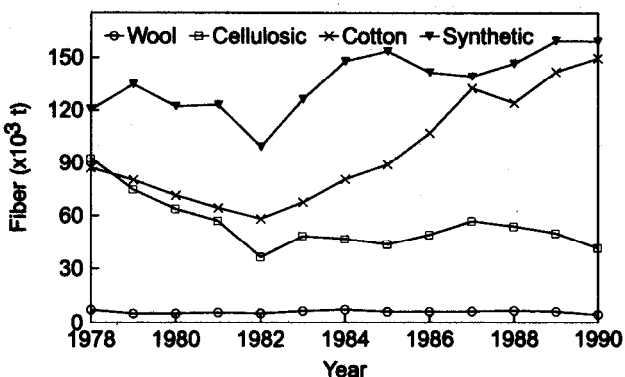


Figure 19—Fiber consumed in U.S. production of drapery and upholstery (Fiber Organon 1992a; Textile Economics Bureau 1985, 1989f).

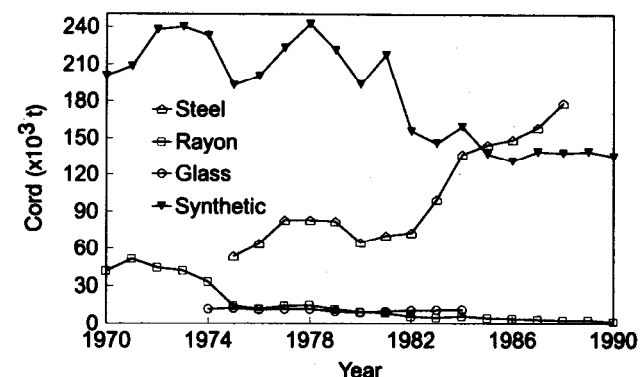


Figure 22—Fiber consumed in U.S. tire cord and cord fabric production. Data for steel prior to 1975 not available; data for glass prior to 1974 or after 1984 not available (Fiber Organon 1992a; Textile Economics Bureau 1973a, 1974, 1975, 1976, 1977, 1978, 1979a, 1980c, 1981, 1982, 1983, 1986b, 1989a).