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FACTS AND FIGURES ON ASBESTOS
(INCLUDING FRICTION PRODUCTS)

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CONTENTS

8001 1601

DESCRIPTION

The varieties of asbestos most used commercially are chrysotile, amosite, crocidolite and anthrophyllite. Chrysotile accounts for approximately 95% of all asbestos consumed commercially and is of the serpentine group of fibers. Other varieties are of the amphibole group of fibers. While varieties differ in chemical compositions, they share a similar structure of linear chains of silicate tetrahedra. The following represents the approximate chemical formula for each variety:

Chrysotile	$3MgO\ 2SiO_2\ 2H2O$
Crocidolite	$Na_2O\ Fe_2O_3\ 3Fe\ O\ 8SiO_2\ H_2O$
Amosite	$1.5\ MgO\ 5.5\ FeO\ 8SiO_2\ H_2O$
Anthrophyllite	$7MgO\ 8SiO_2\ H_2O$

The properties of asbestos that give it commercial value are its fibrous structure, the great strength of its fibers, its resistance to high temperatures and to certain types of chemical attack and electrical conductance. Thermal stability is limited by asbestos metamorphosis, at specific fusion points, to other mineral forms.

Asbestos is graded by fiber length in nine groups. Group 1 and 2 are a longer, unmilled crude form. Group 3 thru 9 are progressively shorter and constitute "milled asbestos". Price decreases from long to short lengths or grades (Attachment 1).

The lower limit for economical asbestos production is 4% asbestos containing ore. Canadian reserves presently average 6% asbestos. As mine age increases, the percent of fiber recovery decreases.

Friction Materials

The properties for which asbestos is used in friction materials include its capacity for thermal stability, its ability to act as a reinforcing agent, as a filler, for the regulation or inhibition of resin flow, its lower abrasion than other fillers of its price range, and its dispersion of metal chips and other particulates. Fiber lengths of #4 to 7 dominate the friction materials.

Gaskets and Packing

Chrysotile use in gaskets and packing is accounted for by its strength, resiliency, durability, toughness and thermal stability. Fiber length ranges from grades #4 to 7.

ASBESTOS INDUSTRY

Raw Material

From 1971 to 1975 between 80-85% of the asbestos consumed domestically was imported. Of the imported asbestos nearly 96% orginated in Canada. The milling segment of the industry is usually located geographically next to the mine. The mines and

8001 1602

Raw Material (continued)

mills are owned and operated by the same parent corporation. Four corporations (Johns-Manville, Raybestos-Manhattan, Jim Walker and Asarco) not only control large mining interests in Canada, but also nearly 35% of the American asbestos products market. Asbestos fiber mined in California (80% asbestos) is generally too short to be utilized in friction and related formulations. Ford suppliers for the most part purchase fiber from Johns-Manville, Quebec. As of 1975, 835,000 short tons/yr. of fiber producing capacity existed at this location.

Fabricators

In manufacturing, six firms control 50% of the market. (Economic Information Systems, 1976)

Company	Estimated 1975 Asbestos-Product Sales ($ Million)	Approximate % of U. S. Market
Johns-Manville Corporation	240	18
Raybestos-Manhattan	140	10.5
GAF	114	8.5
Bendix	72.5	5.5
Jim Walker (Celotex)	71	5.5
Armstrong Cork	60	4.5

Asbestos products manufacturing plants are characterized by a high degree of specialization. The typical plant is apt to be a single-product operation whose product is geared to a specific industry. The U.S. Bureau of Census identified 23 establishments manufacturing friction materials. Twenty-one of these constituted 75% or more specialization. A survey of asbestos manufacturing facilities reveals most plants employ over 100 workers. Differences in plant capacities are therefore determined by installed machines, automation etc.

SUPPLY/DEMAND

U.S. Supply and Demand

U. S. asbestos supply is a combination of imports, domestic mine production, industry stockpiles and government stockpile releases. The importance of such is illustrated by data from the U. S. Department of the Interior, Clifton, 1975.

Thousand Short Tons - 1974

Components of U.S. Supply	
Domestic Mines	113
Government Release	29
Imports, Chrysotile	747
Imports, Crocidolite	11
Imports, Amosite	8
Industry Stocks Jan 1	103
TOTAL	1011

8091 1603

Asbestos (Continued)

Thousand Short Tons - 1974	
Distribution of U.S. Supply	
Government Acquisition	-
Industry Stock Dec 31	103
Exports	62
Industry Demand	846
U. S. Demand Pattern	
Friction Products	80
Packing and Gaskets	29
Total U.S. Demand (includes all asbestos products)	846

Forecasts

U.S. Department of Interior, Clifton, 1975, projections to year 2000 for friction and gasket materials are given in thousand short tons:

	1973	Forecast Base	Forecast Range Low	High	Probable
Friction Products	79	150	110	144	118
Gaskets and Packing	26	75	75	75	66

Long Term Source of Supply - 1976 Data

Canada	1,700,000 Tons
U.S.S.R.	3,000,000 Tons
So. Africa	400,000 Tons
So. America	80,000 Tons
All Other	800,000 Tons

Presently identified sources for future growth (over the next 10 years) are:

U.S.S.R.	500,000 Tons
So. America	60,000 Tons
Africa	100,000 Tons
Mexico	50,000 Tons
Europe	100,000 Tons

Worldwide production of asbestos fiber has increased from 4,330,000 tons per year in 1965 to 5,980,000 tons per year in 1976 (3% per year). Due to the maturity of the asbestos industry the yearly growth in supply and demand is estimated to be 2.5-3%.

FRICTION MATERIALS

Friction materials are used in practically all industries as a key component in clutches for transmitting torque, brakes for slowing down or stopping motion, or as torque limiters. Asbestos is an important ingredient in friction material products because it imparts strength, good friction properties, can withstand high temperatures and is a good insulator.

Use

U.S. demand for asbestos in friction products has ranged from 65-80 thousand short tons from 1964-1974. This amounts to approximately 9% of the total U.S. asbestos consumption. U.S. Bureau of Census figures indicate during the five year period from 1967-1972 the shipment value of asbestos friction materials increased by 45%, compared to the 23% increase for the four year period from 1963-67. Asbestos brake materials account for 65.6% of the total value of asbestos friction materials.

Plants

Eight manufacturers accounted for nearly 75-80% of the total estimated sales of asbestos friction products in 1975 (Economic Information Systems, 1976, Margolin and Igwe).

Company	Plant Location	1975 Estimated Sales ($ Million)
Raybestos	Conn., Pa., Ind., Calif.	110
Bendix	N.Y., Tenn.	72.5
Abex	Ohio, Mich., Va.	60.1
G.M.	Ohio	30
H.K. Porter	Ind., Ky.	26
Chrysler	Mich.	—
Borg Warner	Illinois	—
World Bestos	Indiana	18.8

As would be expected for a mature industry, most of the plants and equipment are old, usually over forty years of age. Production processes have changed only marginally over the years, and labor rather than capital intensity appears to the norm in most of the older plants (Margolin and Igwe, 1975).

Future Projections

Asbestos demand for friction products is projected to year 2000 at an annual growth rate of 1.5%. Based on the forecasted number of vehicles to be produced in the year 2000 (approximately double 1973 production) and on the assumption that the use of asbestos per vehicle will remain at present levels, asbestos demand in vehicles is

projected to 118,000 tons. In addition to using asbestos in brake linings, cars equipped with automatic transmissions get their drive from metal transmission discs which are covered with a super-tough asbestos paper. The average vehicle contains 8-12 of these. Output of over 8 million automatic transmissions annually require asbestos disc paper production in hundreds of tons.

Materials

The average composition of a typical automotive brake lining incorporates asbestos, phenolic resin, cashew-nut shell, graphite products (to lower the friction coefficient or reduce noise), aluminas or silicas (to improve wear), and metal or metal oxides (improved performance). A typical formulation would incorporate the following:

Asbestos	55
Resins	28
Oxides	9
Metals	3
Carbon	5

Alternatives to Asbestos

Possible asbestos alternatives for friction materials include the following:

glass fiber	Overall strength is lower but strong enough for friction materials. At temperatures during braking operations glass fiber melts, even below the operating surface.
steel wool	Overall strength is lower and the cost is higher. In addition, the material hardness of steel wool damages the brake drums.
mineral wool	Overall strength is very low and brittle to the extent of limiting mixing processes.
carbon fiber	Main properties are good, but somewhat inferior to asbestos. A major consideration is cost, which is more than asbestos.
sintered metals and cermets	Presently used to manufacture brake linings for aircraft. Wear properties are not good enough for automotive applications and the cost is higher.

Asbestos Emissions

The major effect of braking appears to be in separating bunches of fibers and reducing their average length. Brake lining debris contains a high percentage of fiber shorter than 2 um, with a substantial portion shorter than .5 um. Asbestos remaining in the brake lining is converted by thermal or other physical processes into magnesium silicates or other re-crystallised magnesium silicate structures different from asbestos.

ATTACHMENT 1

FIBER GRADES

ASBESTOS FIBER GRADES USED IN AUTOMOTIVE APPLICATIONS

Product	Asbestos Fiber Grades	Approximate Asbestos Content
Gaskets		
"Sheeter"	4T, 5K	70-75%
"Beater Ad"	PB #5 (Similar to 7D Fiber Grade)	80-85%
Brakes		
Linings	7F, 7H, 7M	50-65%
Discs	5K, 5R	45-60%
Clutch Facing		
Woven	3T	65-70%
Transmission Bands		
Asbestos Paper	5Z, 7R	80-90%
Plastic Fillers	7K, 7T, 7TF	Up to 40%
Sealants	7R, 7TF	5-10%
Undercoatings	7RF	15-25%

Asbestos Distribution (Short Tons) by Grade

Grade	Friction Products	Packing and Gaskets
1	-	
2	-	100
3	5600	1900
4	1300	7500
5	29,500	7500
6	6300	1400
Chrysotile	36600	10,300
Crocidolite	79300	28,700
Amosite		100
Anthrophyllite	200	
Total Asbestos	79,800	28,800

8001 1607

ATTACHMENT 1

Cost

ASBESTOS FIBRE PRICE INCREASES SINCE 1970

	Asbestos Grade	January 1970	Average Annual Compound Percentage Increase	
			Present	
Long Fiber	3T	425.50	1,093	14⅛%
	4T	218.00	561	14⅛%
	5K	184.00	434	13%
	5R	156.50	368	12⅛%
	PB #5	83.50	178	11⅛%
	7F	85.00	168	10%
	7H	72.60	139	10%
	7K	59.70	117	10%
	7M	53.60	106	10%
	7R	50.50	99	10%
	7T	48.40	97	10⅛%
	7RF	52.00	98	9⅛%
Short Fiber	7TF	52.00	98	9⅛%

During the sixties there were virtually no price increases. The price, during that based upon constant dollars, actually went down.

Information in Attachment 1 supplied by Johns-Manville

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