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# Handling Asbestos

## Chrysotile Asbestos in Plastics

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Asbestos has received a great deal of attention and publicity in recent years, especially after it was designated a "target health hazard" by OSHA and a "hazardous air pollutant" by the EPA. Many of the articles on asbestos by the press have been emotionally oriented or distorted and, in some cases, stories have been sensationalized, based on obvious misinterpretation of facts. The use of half-truths or unsubstantiated statements has led to general confusion and the unfair castigation of asbestos and products containing asbestos. The purpose of this paper is to put the matter of asbestos use and asbestos hazards into a logical and practical perspective. In this paper, the different types of asbestos and their many uses are discussed, along with government regulations controlling the use of asbestos. The health hazards associated with asbestos, both occupational and environmental, and some industrial experience with air sampling and dust control measures are also covered.

KEY WORDS: Asbestos; Plastics; Air pollution; Toxicology.

### What is Asbestos?

Asbestos is a commercial or generic term used to describe six naturally occurring "asbestiform" minerals that are fibrous, hydrated metal silicates. The six varieties are divided into two classes—serpentine and amphibole—based on their crystal structure. Chrysotile is the only member of the serpentine class, while the amphiboles include crocidolite, amosite, anthophyllite, tremolite, and actinolite. Chrysotile is by far the most-used variety and accounts for over 95% of U.S. consumption, as noted in *Table* 1.

Crocidolite, also known as blue asbestos, is imported from South Africa. Because of its high mechanical strength and good resistance to acids and alkalis, it is used to reinforce a limited variety of plastics where its pronounced color is not objectionable. Amosite, also imported from South Africa, is used primarily in thermal insulation. Although there are some deposits of anthophyllite in the U.S., most of it is imported from Finland. It is used primarily as a filler for polypropylene and in insulating materials. A comparison of the four varieties of asbestos which are of commercial importance is presented in *Table* 2. It should be noted that there are significant differences between chrysotile and amphiboles with regard to chemical composition and certain physical properties.

### Where is Asbestos Used and Why?

Asbestos has served mankind for more than 100 years in a broad variety of applications. The general areas in which asbestos is used in the U.S. are shown in *Table* 3. Based on information from asbestos producers and consumption surveys, it is estimated that the plastics industry uses about 33% of the 800,000 tons consumed annually, which makes it the largest single user of asbestos fiber.

The largest uses of asbestos by the plastics industry are in vinyl-asbestos floor tile and in phenolic molding compounds. It is also used in other plastics such as polypropylene, polyester, nylon, melamine, epoxy, silicone, and vinyl. Asbestos provides a valuable function in such products as brake linings, clutch facings, electrical components, automotive parts, furniture, boats, sealants, coatings, adhesives and mastics. The most important functions of asbestos in plastics are reinforcement, dimensional stability, heat resistance, flow control, and general-purpose filling. Most of the functions are supplied by short-fiber chrysotile asbestos fiber, although longer chrysotile fibers and other asbestos varieties are sometimes required for particular properties.

### Why Use Chrysotile?

Among the several advantages of chrysotile, which set it apart from the amphibole minerals and account for its widespread and increasing usage, are world-wide availability, mechanical strength, flexibility, positive surface charge, low iron content, softness, and low refractive index. It is conservatively estimated that chrysotile asbestos is used in over 3,000 applications and, in most of these applications, it is an essential ingredient for which no replacement is readily available.

The information in *Table* 1 shows that the use of chrysotile asbestos and its share of the total market are steadily increasing. This is due partly to technical advances permitting the broader use of chrysotile in plastics and the general decline in the use of asbestos in certain fireproofing and insulating materials. In addition, there is increasing evidence that crocidolite and amosite are more hazardous to

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Table 1—Apparent U.S. Consumption of Asbestos, Tons[a]

| Year | Total | Chrysotile | Amosite | Crocidolite |
|---|---|---|---|---|
| 1967 | 720,583 | 686,044 (95)[b] | 12,558 (1.7) | 14,917 (2.1) |
| 1968 | 817,363 | 775,711 (95) | 20,467 (2.5) | 13,965 (1.7) |
| 1969 | 784,321 | 749,708 (96) | 14,618 (1.9) | 10,558 (1.3) |
| 1970 | 728,131 | 695,770 (96) | 14,261 (2.0) | 8,936 (1.2) |
| 1971 | 758,571 | 729,272 (96) | 14,580 (1.9) | 6,953 (0.9) |
| 1972 | 808,554 | 791,020 (98) | 7,125 (0.9) | 5,374 (0.7) |

(a) Information based on import and production data from U. S. Bureau of Mines' Minerals Yearbooks.
(b) Percent of total shown in parentheses.

Table 3—Apparent U.S. Consumption of Asbestos By General Use Areas

| Area of Use | Percent of Consumption |
|---|---|
| Construction | 40 |
| Floor tile | 15 |
| Felt paper | 15 |
| Friction and packing | 14 |
| Insulation | 3 |
| Textiles | 2 |
| Other | 11 |

human health than chrysotile.[1] Since 1970, the use of crocidolite in Britain has been restricted after a panel of experts "concluded there was sufficient evidence to suggest other types of fibre should be substituted for crocidolite wherever possible."[2]

## What is the Asbestos Hazard?

It is readily accepted that asbestos, like many other foreign bodies, can cause disabling lung damage (pulmonary fibrosis), commonly referred to as asbestosis. This disease and bronchogenic carcinoma (lung cancer) are the two most common asbestos-related diseases. It is important to note that, based on epidemiological data, these diseases have occurred primarily in workers with high, long-term exposures to asbestos dust. It is of further interest that one noted researcher has reported that neither of these diseases is peculiarly related to or caused solely by the inhalation of asbestos fiber.[3] Another important consideration is the relation between cigarette smoking and lung cancer, as reported by Dr. E. C. Hammond and Dr. I. J. Selikoff.[4] In this study, they reported that: "It seems clear, then, that lung cancer is uncommon among asbestos insulation workers who have no history of cigarette smoking and that if the risk is increased, such increase is not great."

A third disease, mesothelioma, has more recently been associated with persons exposed to asbestos. Mesothelioma is an extremely rare cancer of the lining of the chest (pleura) or the abdominal cavity (peritoneum). In contrast to the lung diseases, there is some evidence that mesothelioma can occur after brief exposures to relatively high fiber levels.

According to the 33-member Advisory Committee on Asbestos Cancers of the International Agency for Research on Cancer (a division of the World Health Organization): "There is evidence of an association of mesothelial tumors with air pollution in the neighborhood of crocidolite mines and of factories using mixtures of asbestos fiber types. The evidence relates to conditions of many years ago. There is evidence of no excess risk of mesotheliomas from asbestos air pollution which has existed in the neighborhood of chrysotile and amosite mines. There are reported differences on incidence of mesothelioma between urban and rural areas, the causes of which have not been established. There is no evidence of a risk to the general public at present."[5]

The same body quoted above has also concluded that there is, at present, no evidence of lung damage by asbestos to the general public; and such evidence as there is does not indicate any risk of cancer resulting from asbestos fibers present in water, beverages, food, or in the fluids used for the administration of drugs.

While there seems to be general agreement that the public is not in any present danger from asbestos, it is also recognized that excessive, long-term occupational exposure can cause serious health problems. Also, if man-made emissions are not controlled, then environmental contamination ~~could~~ could approach harmful levels. During the past two years, significant legislation has been enacted by th Federal government to reduce a control occupational exposure to bestos fibers and to minimize emissions to the environment. tional standards or regulatior been proposed or enacted b states and local government

Table 2—Comparative Data for Asbestos Minerals[a]

| Formula | Chrysotile $3MgO2SiO_2 \cdot 2H_2O$ | Crocidolite $Na_2O \cdot Fe_2O_3 \cdot 8SiO_2 \cdot H_2O$ | Amosite $1.5MgO \cdot 5.5FeO \cdot 8SiO_2 \cdot H_2O$ | Anthophyllite $7MgO \cdot 8SiO_2 \cdot H_2O$ |
|---|---|---|---|---|
| Composition, % | | | | |
| $SiO_2$ | 37—44 | 49—53 | 49—53 | 56—58 |
| MgO | 39—44 | 0—3 | 1—7 | 28—34 |
| FeO | 0—6 | 13—20 | 34—44 | 3—12 |
| $Fe_2O_3$ | 0—5 | 17—20 | — | — |
| $Al_2O_3$ | 0—2 | — | 2—9 | 0—2 |
| $H_2O$ | 12—15 | 2—5 | 2—5 | 1—6 |
| CaO | 0—5 | — | — | — |
| $Na_2O$ | — | 4—8 | — | — |
| $CaO+Na_2O$ | — | — | 0—3 | — |
| Crystals | Fine fibers | Brittle fibers | Prismatic | Prismatic |
| Color | Gray green | Blue | Gray/brown | Gray |
| Texture | Soft silky | Harsh | Harsh | Harsh |
| Flexibility | Very good | Good | Good | Poor |
| Hardness, mohs | 2.5-4 | 4 | 5.5-6 | 5.5-6 |
| Fiber diameter, A | 180-300 | 600-900 | 600-900 | 600-900 |
| Tensile, mpsi | 800 | 600 | 200 | <4 |
| Surface charge | Positive | Negative | Negative | Negative |
| Resistance to acid | Poor | Good | Good | Very good |
| Resistance to alkali | Good | Good | Fair | Good |

(a) Sources: Modern Plastics Encyclopedia (1973), and Encyclopedia of Chem. Tech., Vol. 2.

## Summary of OSHA F

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the following Congressional purpose: "To assure so far as possible every working man and woman in the nation safe and healthful working conditions and to preserve our human resources." The Act established the Occupational Safety and Health Administration (OSHA) within the Department of Labor, which has responsibility for administration and enforcement. Research and related functions are handled by the Department of Health, Education and Welfare (HEW) through the National Institute of Occupational Safety and Health (NIOSH). Five million employers and 60 million of the nation's 80 million workers are covered by OSHA. Specifically excluded from coverage are government employees and operations which are protected under other federal health and safety laws. In a news release issued January 4, 1972, OSHA announced a Target Health Hazards Program aimed at improving health factors associated with working conditions. The following five substances were designated to be the focus of initial and concerted efforts by OSHA and NIOSH: asbestos, cotton dust, silica, lead, and carbon monoxide.

At the present time, new standards have been established only for asbestos, although, of the 8,000 toxic substances on the NIOSH list, only 500 are covered by standards and many of those need updating. The new Standard for Exposure to Asbestos Dust was published in the *Federal Register*, Vol. 37, No. 110, on June 7, 1972. The basic exposure standard is an 8-hr time weighted average (TWA) of five fibers, longer than 5 micrometers, per cubic centimeter of air. The TWA limit is to be reduced to two fibers per cubic centimeter on July 1, 1976. A peak concentration of 10 fibers per cubic centimeter is not to be exceeded at any time. All of the fiber concentrations are those to which an employee may be exposed without protective clothing and equipment. The first basic requirement of the new standard is monitoring to determine whether or not fiber concentrations are in excess of the exposure limits. Some asbestos suppliers provide a monitoring service to customers, and a similar service may be obtained from state health department officials, insurance carriers, or private consultants. The law requires that monitoring be repeated as necessary to ensure that employees are not exposed to levels in excess of the exposure limits.

Improper interpretation of the regulations has created many misconceptions about equipment and procedures needed to properly use asbestos. If exposure limits are not exceeded, there are no further compliance requirements except for medical examinations. Medical examinations are required for all employees in any occupation exposed to airborne concentrations of asbestos fibers. The examinations are relatively simple and should cost no more than $50 per year, per employee.

Respirators and special clothing are required in the construction trade for the spray application of insulation and fireproofing materials, and for the removal of such materials. This special protection is not required for any other use of asbestos unless exposure limits are exceeded. This is also true for other items such as specially equipped tools, change rooms, clothes laundering, and waste disposal. Respirators are not a substitute for engineering controls, but the law allows their use while controls are being implemented, in special situations where controls are not feasible or adequate, in emergencies, and for infrequent short-term job assignments. Caution labels are required on products containing asbestos except where the fibers have been modified by a bonding agent or other material to prevent dusting during any normal subsequent use or handling. Besides raw asbestos fiber, products which require package labeling could include: dry acoustical spray products and joint cements, unsaturated roofing felt and textiles, and some insulating products made without adequate binders. The labeling of a product does not prohibit its use. It should be noted here that in at least 90% of the products containing asbestos, the fibers are solidly locked into the product thereby presenting little danger of dust generation during normal use and handling of the product.[6]

## EPA Standards

Whereas OSHA is responsible for the protection of the worker, the Environmental Protection Agency (EPA) is charged with improving the environment to which the general public is exposed. On March 31, 1971, asbestos, along with beryllium and mercury, was identified as a "hazardous air pollutant" by the Administrator of the EPA. National Emission Standards for asbestos were then published by EPA in the *Federal Register*, Vol. 38, No. 66, April 6, 1973. Although no numerical emission standards were established, operating criteria are prescribed to prevent or limit asbestos emissions to the outside air from asbestos mills, roadways, certain manufacturing operations, building demolition, and the spray-on application of materials used to insulate or fireproof equipment and machinery. The law further requires that spray-on materials used to insulate or fireproof buildings, structures, pipes, and conduits shall contain less than 1% asbestos on a dry-weight basis. This should significantly reduce emissions to which the general public may be exposed, especially in large urban areas.

". . . the Administrator (of EPA) has determined that, in order to provide an ample margin of safety to protect the public health from asbestos, it is necessary to control emissions from major man-made sources of asbestos emissions into the atmosphere, but that it is not necessary to prohibit all emissions.

"In this determination, the Administrator has relied on the National Academy of Sciences' report on asbestos, which concludes: "Asbestos is too important in our technology and economy for its essential use to be stopped. But, because of the known serious effects of uncontrolled inhalation of asbestos minerals in industry, and uncertainty as to the shape and character of the dose-response curve in man, it would be highly im-

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prudent to permit additional contamination of the public environment with asbestos. Continued use at minimal risk to the public requires that the major sources of man-made asbestos emission into the atmosphere be defined and controlled.' "[7]

## What is Industry Doing?

The Asbestos Information Association/North America reports that, during the past 30 years, the asbestos industry has spent millions of dollars to improve mining, milling, and manufacturing methods.[8] The establishment of safer working conditions has been a prime target and this work continues unabated and in close association with government agencies and independent medical researchers.[9]

The ultimate goals of the asbestos industry are: Reduction of work-area dust to minimum levels; Protection of workers from asbestos-related diseases; Maintenance of environmental emissions at levels low enough to preclude public endangerment.

## Air Sampling

In order to comply with OSHA standards and to determine the need for dust control measures, air monitoring should be conducted in areas where asbestos is regularly handled or used. OSHA standards require that "all determinations of airborne concentrations of asbestos fibers shall be made by the membrane filter method at 400-450X (magnification) (4 millimeter objective) with phase contrast illumination."[10] The equipment for collecting air samples costs less than $400 and is readily available. A phase contrast microscope can be obtained for as little as $600, or an existing microscope can be modified for "counting" the asbestos fibers in compliance with NIOSH criteria.[11]

Air samples have been collected and analyzed on a regular basis by the asbestos industry for years. Except for a few applications where dust control is an engineering problem, industry is finding that dust levels are already within acceptable standards or that minimum changes are necessary to achieve compliance. Although data on many asbestos/plastic applications are not available, the summary in *Table* 4 is typical of our measurements of dust levels during asbestos handling in various types of plants and operations. The dust levels reported are ceiling concentrations, and it should be noted that the allowable OSHA level is 10 fibers/cc. In most cases, the TWA exposure level would be well below OSHA standards. Most of the data were collected before the installation of any special dust-control measures. Monitoring often shows that obviously dusty conditions are caused by materials other than asbestos. This does not preclude the need for controls, but it could change their scope and facilitate compliance with government regulations. Because of "bad press," asbestos is frequently ordered out of use without regard to whether or not a hazard actually exists due to air contamination. If acceptable dust levels are feasible, there is no need to replace asbestos at the expense of product quality or economic penalty. Gordon Everett of EPA points out that information on the biological effects of asbestos is very limited and that the effects of many substitutes have not been investigated at all. Before asbestos is replaced, it should be certain that a safer alternative is available.[12]

Table 4—Typical Air Sampling Results[a]

| Type Plant Or Operation | Ceiling Concentration, Asbestos Fibers/cc |
|---|---|
| Floor tile | 1-3 |
| Polyester | 1-3 |
| Phenolic compounding | 2-5 |
| Handling phenolic | 3-14 |
| Caulks and sealants | 0-8 |
| Gypsum compounds | 2-9 |

(a) Source: Union Carbide Corp., from air monitoring reports.

Obviously there are more people exposed to products containing asbestos than there are to raw asbestos fibers. As noted previously, more than 90% of the asbestos used in this country is in products in which the asbestos is "locked in" or bound with cement, plastics, or other binders, so that there is no release, or at least no significant release, of fibers in work areas or to the environment. Materials or products with locked-in fibers would include: floor tile, polyester resins, phenolics, sealants, coatings, brake linings, friction materials, rubber, roofing compounds, and reinforced plastics. Since an abrading action on some of these products could release asbestos fibers, appropriate monitoring and/or control measures should be instituted if it is thought that such action would release fibers.

## Dust-Control Measures

Asbestos producers and users are spending a considerable amount of time and money on various dust-control measures. Conventional means to achieve minimum dust levels include: filtered ventilation systems on process equipment, local ventilation for saws and similar tools, conversion to a "wetted" operation, leak-proof packaging, vacuum clean-up, more care in bag disposal and other asbestos waste handling, and automatic bag openers. Unusual innovations include: pelletized asbestos, special packaging, and treated products.

Only short-fiber chrysotile is available as pellets, but this product serves a fair portion of the asbestos market. Pellets not only reduce dust during conventional handling but they are also available in bulk hopper cars and can be transferred and used in totally enclosed systems. Barring leaks in the system, dust in work areas is virtually eliminated. Used in bulk, asbestos pellets also reduce shipping costs, eliminate warehouse storage and handling, facilitate automation, reduce clean-up, and eliminate bag handling and disposal. The pellets contain no binder and are friable enough to be dispersed in dry form or in aqueous or resinous systems with conventional high-shear grinding equipment.[13]

Several types of special packaging are currently available, and suppliers consider customer requests for unusual requirements. The floor tile industry can obtain asbestos in plastic bags which can be added directly to the compounding operation. Asbestos in bleached paper bags assembled with water-soluble glue and printed with water-dispersible ink can be added directly to paper-making finishes or acoustical tile formulations.

Although "wetted" asbestos is not generally available, most suppliers are working with customers to provide "dustless" products. When justified by market demand, asbestos can be treated with water, mineral spirits, glycol, or other materials compatible with the application or system.

## Conclusion

Asbestos is one of industry's many raw materials which involves a potential hazard when not used with reasonable respect and care. Although all forms of asbestos are recognized as hazardous to health when inhaled excessively, there is growing evidence that crocidolite and amosite are more hazardous than chrysotile. Fortunate-



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ly, the plastics industry uses primarily chrysotile asbestos and, in most products, the fibers are locked-in to prevent airborne contamination. Although asbestos dust levels are generally lower than expected, industry continues to expend large amounts of time and money to further improve the quality of the workplace. Although the general public is not currently in danger, occupational controls are required to prevent future environmental contamination.

Chrysotile asbestos is an important and necessary raw material, vital to the nation's safety and economy; and, with proper control, it can be used safely and in compliance with government regulations. Medical, scientific, government, and industrial personnel must continue to work closely together to establish reasonable exposure limits, provide safe work areas, and eliminate any possibility of public endangerment. □

## References


(1) Enterline, P. E. and Henderson, V., *Arch. Environ. Health, 27,* 312 (Nov. 1973).

(2) Wagner, J. C., *Ann. Occup. Hyg., 15,* 61 (1972).

(3) Wright, G. W., statement before U.S. Dept. of Labor, Occupational Safety and Health hearing on proposed occupational asbestos standard, March 16, 1972, p. 3.

(4) Hammond E. C. and Selikoff, I. J., "Relation Of Cigarette Smoking To Risk of Death of Asbestos-Associated Disease among Insulation Workers in the U.S.A.," presented at meeting of the Working Group to Assess Biological Effects of Asbestos, International Agency for Research on Cancer. Lyon, France (Oct. 4, 1972).

(5) 'Report of the Advisory Committee on Asbestos Cancers," *Brit. J. Industr. Med., 30,* 180 (1973).

(6) "Asbestos," *National Safety News* (Oct. 9, 1973).

(7) "National Emission Standards for Hazardous Air Pollutants," *Federal Register, 38,* No. 66, 8820 (April 6, 1973).

(8) "Protecting the Asbestos Worker," Booklet No. 101D37, The Asbestos Information Association/North America, p 5.

(9) Selikoff, I. J., *Industr. Medicine, 39,* No. 4, 21 (April 1970).

(10) "Standard for Exposure to Asbestos Dust," *Federal Register, 37,* No. 110, 11320 (June 7, 1972).

(11) Bayer, S. G., et al, "Equipment and Procedures for Mounting Millipore Filters and Counting Asbestos Fibres by Phase-Contrast Microscopy," Bureau of Occup. Safety and Health, U.S. Dept. of Health, Education, & Welfare (Feb. 1969).

(12) "Asbestos Health Question Perplexes Experts," *Chem. Eng. News,* 18 (Dec. 10, 1973).

(13) Myers, J. L., "Calidria Asbestos Pellets," *ASBESTOS* (Oct. 1971).