# Risk of Asbestos

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## Abstract

*Related information pertaining to asbestos, the best insulator known to man, is discussed in the paper. The hazards associated with the use of asbestos and how to deal with them is also presented.*


Keywords: Asbestos, health hazards

## I. Introduction

Asbestos, the best insulator known to man[1] is the name applied to a number of naturally occurring fibrous metamorphic silicate minerals. It is found in the environment due to the natural weathering of rocks, mining and use of asbestos products. It comes from a Greek word which means "unquenchable" in reference to its being resistant to fire and heat. Being of flexible fibers, it is woven to make fabrics for heat-resistant and insulating materials. And for many centuries, small cloths woven from asbestos were a luxury item in the handling of hot items in kitchens and foundries.

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Most asbestos fibers are invisible to the unaided human eye. They are very stable in the environment and are virtually indestructible. They do not evaporate into air or dissolve in water, and they are not broken down over time.[2]

In the United States, commercial use of asbestos began in the early 1900's and peaked in the period from World War II into the 1970's. Under the US Clean Air Act of 1970, the Environmental Protection Agency (EPA) began regulating many asbestos-containing materials which, by EPA definition, are materials with more than 1% asbestos.[1]

## II. Properties and Applications

Asbestos has several physical properties that make it almost a superstar in the world of industrial chemistry. Its tensile strength surpasses that of steel. It has tremendous thermal stability, electrical resistance and is non-flammable. It can be divided into fine fibers that are long, thin, strong and flexible enough to be spun into a material with above-mentioned properties.

Thus, asbestos binds with other insulating materials to create the ultimate construction materials. When asbestos is used for its resistance to fire or heat, the fibers are typically mixed with cement or woven into fabric or mats. It is used in brake shoes and gaskets for its heat resistance, and in the past was used on the electric oven and hotplate wiring for its electrical insulation at elevated temperature, and in buildings for its flame-retardant and insulating properties, its tensile strength, flexibility and resistance to chemicals.[3]

Asbestos has a very high melting point (i.e., 600-900°C for amosite, 800-850°C for chrysotile, 1,040°C for tremolite, 950°C for anthophyllite, and 800°C for crocidolite).[4]

Since asbestos has so many useful properties, it has been used in over 3,000 different products. The most common uses of asbestos are in the following applications.[1]

- thermal and acoustic insulation
- fireproofing
- textiles
- asbestos concrete
- plastic products (vinyl floor tiles)

- paper products
- gasket, packaging
- roofing felts, papers
- electrical

## III. Production and Processes

Asbestos is obtainable by various underground mining methods but the most common method is open-pit mining. Only about 6 per cent of the mined ore contains usable fibers. The fibers are separated from the ore by crushing, air suction, and vibrating screens, and in the process are sorted into different lengths or grades. The most widely used method of grading, the Quebec Standard Test Method, divides the fibers into seven groups, the longest in Group 1 and the shortest, called milled asbestos, in Group 7. The length of the fibers, as well as the chemical composition of the ore, determines the kind of product that can be made from the asbestos. The longer fibers have been used in fabrics, commonly with cotton or rayon, and the shorter ones for molded goods, such as pipes and gaskets.[5]

As mentioned above, asbestos is mixed with other materials to actually form the products. Floor tiles, for example, may contain only a small percentage of asbestos. Depending on what the product is, the amount of asbestos in asbestos containing materials (ACM) may vary from 1%-100%.[2]

## IV. Classification and Types of Asbestos

Asbestos is divided into two mineral groups based on the crystalline structure:[1]

1. Amphibole Group – The amphiboles are double-chain silicates also called inosilicates. The basic structural unit is (Si4O11)-6 with side groups that are responsible for the overall amphibole structure. Amphiboles are distinguished from one another by the amount and positioning of metal atoms including: sodium, calcium, manganese, magnesium, iron (II), iron (III) and aluminum. There is a complete

solid solution between Na and Ca end members and between Mg and Fe end members.

All but one form of the specific types of asbestos, chrysotile, are amphiboles. Under the amphibole group are the following: amosite, crocidolite, actinolite, anthophyllite,and tremolite. The amphibole fibers more commercially used such as amosite and crocidolite are extremely hazardous. They are very dusty because of their straight and needlelike fibers. They are also highly biopersistent because once in the human body, they can remain indefinitely in the lung tissue and may cause cancer and mesothelioma.

Amosite is usually brown or tan, with much straighter fibers that chrysotile. It is the second most commonly used type of asbestos, comprising approximately 5% of the asbestos placed in buildings and factories. It is sourced from South Africa.[1]

Another 4% of the asbestos consumed is crocidolite. It is sourced from Africa and Australia. Crocidolite is a fairly rare form of asbestos. It is unique because of its very obvious blue color. Crocidolite fibers appear long and straight, much like amosite. Blue asbestos is commonly thought of as the most dangerous type of asbestos. It is used in specialized high temperature applications.

Tremolite has been used in laboratories for filtering chemicals. Actinolite is used for industrial asbestos. There is not much reported use of anthophyllite.

2. Serpentine Group – The serpentine group of minerals has the formula $Mg_3Si_2O_5(OH)_4$. Its structure is a bending sheet. There are only three known serpentines. Two are massive and fine grained (not of asbestos form). Chrysotile is the only one in which the sheets are continuous and bend to form continuous tubes, which give the mineral the fibrous habit related to asbestos.

Chrysotile, the most common asbestos type is usually white or off white, with long wavy fibers and mostly mined from Canada and South Africa. In some mines, the fibers are exceeding long and flexible, making chrysotile excellent for weaving into fire and heat resistant cloth. Shorter chrysotile fibers are more suited to be used as binders and strengtheners in plastics, cement or

insulation. It is the most common type of asbestos found in buildings and accounts for 95% of the world supply of asbestos. It is considerably less hazardous that amphibole fibers. It is less friable, silky in texture, with curly fibers and unlikely to remain suspended in the air. Thus, less of it is inhaled and it does not stay in the lungs very long. The human immune system can eliminate these fibers relatively quickly.

## V. Hazards of Asbestos at Home[5]

Specific asbestos hazards may be found in the home. Among them are as follows:

- Some roofing and siding shingles are made of asbestos cement;
- Houses built that may have asbestos as insulation (between 1930 and 1950 in the First World);
- Asbestos may be present in textured paint and in patching compounds used on wall and ceiling joints; its use was banned in 1977;
- Artificial ashes and embers sold for use in gas-fired fireplaces may contain asbestos;
- Older products such as stove-top pads may have some asbestos compounds;
- Walls and floors around wood burning stoves may be protected with asbestos paper, millboard, or cement sheets;
- Asbestos found in some vinyl floor tiles and the backing on vinyl sheet flooring and adhesives;
- Hot water and steam pipes in older houses may be coated with an asbestos material or covered with an asbestos blanket or tape;
- Oil and coal furnaces and door gaskets may have asbestos infusion;

However, asbestos is not always an immediate hazard. If it can be maintained in good condition it is recommended that it be left alone and periodic surveillance performed to monitor its condition. It is only when asbestos containing materials (ACM) are disturbed or become damaged that it becomes a hazard and the fibers are released and inhaled into the

lungs. The best way to deal with slightly damaged material is to limit access to the area and not to touch or disturb it. If already damaged or worn out such as asbestos gloves, stove-top pads, or ironing board covers, they should be discarded.

And finally, if changes in the home are going to be made that might disturb asbestos containing materials, repair or removal by a professional is needed.

## VI. Environmental Fate

Asbestos fibers are very stable and do not undergo significant degradation and may remain in the environment for decades. They also have no detectible odor or taste.[4]

Friability of asbestos is its ability to easily be turned into dusts with finger pressure. It is this friability that releases asbestos fibers into the atmosphere.[1] Most respirable asbestos fibers are invisible to the unaided human eye because their size is about 3.0-20.0 μm in length and can be as thin as 0.01 μm. In contrast, human hair ranges in size from 17 to 181 μm. Fibers ultimately form because when these minerals originally cooled and crystallized, they formed by the polymeric molecules lining up parallel with each other and forming oriented crystal lattices. These crystals have three cleavage planes as other minerals and gemstones have. But in their case, there are two cleavage planes that are much weaker than the third direction. Thus, when sufficient force is applied, they tend to break along their weakest directions, resulting in a linear fragmentation pattern and hence a fibrous form. This fracture process can keep occurring over and over until they have been broken down to their smallest unit dimensions. For this reason, one larger asbestos fiber can ultimately become the source of hundreds of much thinner and smaller fibers in a normal environment over the course of time. As they get smaller and lighter, they become more mobile and more easily entrained into the air.[3]

Small fibers occur in suspension in air being not volatile and water being insoluble. Large fibers are removed from air and water by gravitational settling at a rate which depends on their size. Small fibers can remain suspended for long periods of time. Fibers with aerodynamic diameters of 0.1 mm can be carried thousands of kilometers in air. Majority of human exposure to asbestos is believed to come from corrosion

of asbestos-concrete pipes where fibers are released into drinking water. While asbestos fibers do not bind to soils, they migrate to ground aquatic waters through soils.

Concentrations of asbestos are usually reported in fibers per milliliter (f/ml) or million fibers per liter (Mf/L). The enforceable standard called Maximum Contaminant Level Goal (MCLG) set by EPA was 7 M fibers per liter.

There is little data on levels of asbestos in animal tissues. Data does not suggest that asbestos will bioaccumulate or biomagnify in the food chain.[4]

## VII. Toxicokinetics[4]

The most common way for asbestos fibers to enter the body is through breathing. Since asbestos is made up of microscopic bundles of fibers, it is releasing dust or fibers into the air where they can be inhaled or ingested. Once inhaled, the fibers have the ability to split along their length into fine fibers. Many of the fibers will become trapped in the mucous membranes of the nose and throat where they can then be removed, but some may pass deep into the lungs, or, if swallowed, into the digestive tract.

In the lungs, the shape and size of the fibers will influence the deposition and fate of the fiber. Mucociliary clearance or macrophage removal will clear some fibers from the lungs. Fibers that are coated by mucus move upward to the throat, after which they are swallowed and then excreted in the feces. Long fibers are cleared more slowly than short fibers. Fibers of less than 1 micron in length are cleared from the lung with a half-life of less than 10 days whereas fibers longer than 16 mm. are cleared with a half-life of greater than 100 days. Nearly all asbestos fibers which are ingested are excreted in the feces within 48 hours.

Fibers that are not cleared from the lungs accumulate gradually with time. Longer fibers that are retained in the lung may undergo a number of processes including translocation, dissolution, fragmentation, splitting or protein encapsulation. Amphibole fibers that are retained in the lungs do not appear to undergo any major changes. Chrysotile fibers, however, appear to undergo some type of breakdown or alteration in the lung. As such, chrysotile asbestos is removed faster than amphiboles since

it fragments. Fragmentation results in the formation of shorter fibers which are then more readily engulfed and moved by a single macrophage.

A few fibers may move through the stomach or intestine to be distributed to other tissues such as the blood, lymph, urine, or various other organs (kidney, heart, liver, spleen, adrenals, pancreas, brain, prostrate, or thyroid tissues). Fibers that are absorbed into the body are transported by the blood to the kidney, where they may be excreted in the urine.

Most asbestos fibers which are ingested are not absorbed across the gastrointestinal tract. Short fibers seem to pass through the gastrointestinal epithelium more easily than longer ones. Asbestos fibers can penetrate into the skin, producing asbestos warts. Asbestos fibers do not readily pass through the skin into the blood.

However, asbestos is not known to cause any acute health problems when people are exposed to it at levels above the Maximum Contaminant Level (MCL) for relatively short periods of time.

## VIII. Health Problems Caused by Asbestos[2]

Asbestosis is a serious, chronic, non-cancerous respiratory disease characterized by lung fibrosis with a latent period of up to 30 years and more. The inhaled asbestos fibers aggravate lung tissues, which cause them to scar. The symptoms of asbestosis include shortness of breath and a dry crackling sound in the lungs while inhaling. In its advanced stages, the disease may cause severe loss of lung function and ultimately respiratory or cardiac failure.

There is no effective treatment for asbestosis. The disease is usually disabling or fatal and was first found in naval shipyard workers. The risk of asbestosis is minimal for those who do not work with asbestos. Those who renovate or demolish buildings that contain asbestos may be at significant risk, depending on the nature of the exposure and precautions taken.

Lung cancer causes the largest number of deaths related to asbestos exposure. It includes cancer of the trachea, bronchus and lung proper. The disease is prevalent in people who are directly involved in the mining, milling, manufacturing and use of asbestos and its products. The most common symptoms of lung cancer are coughing and a change in

breathing. Other symptoms include shortness of breath, persistent chest pains, hoarseness and anemia.

Asbestos has a synergistic effect with tobacco smoking in causing lung cancer. Asbestos workers who smoke are about 90 to 100 times more likely to develop lung cancer than the average.

Mesothelioma is a rare form of cancer that most often occurs in the thin membrane lining of the lungs, chest, abdomen, and rarely heart called the mesothelium. Virtually all cases of mesothelioma are linked with asbestos exposure. It has been documented that about 2 % of all miners and textile workers who work with asbestos and 10 % of all workers who are involved in the manufacture of asbestos-containing gas masks, contract mesothelioma.

People who work in asbestos mines, asbestos mills and factories, and shipyards that use asbestos, as well as people who manufacture and install asbestos insulation, have an increased risk of mesothelioma. People who live with asbestos workers, near asbestos mining areas, near asbestos product factories or near shipyards where use of asbestos has produced large quantities of airborne asbestos fibers are also included.

## IV. Conclusion

The risk of asbestos to the health of its users far outweighs its useful properties as a superstar component material in a wide variety of applications. If its use can not be dispensed with, it must be regulated and periodically monitored.

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