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Asbestos

Guideline

There is no consistent, convincing evidence that ingested asbestos is hazardous. There is, therefore, no need to establish a maximum acceptable concentration (MAC) for asbestos in drinking water.

Identity, Use and Sources in the Environment

Asbestos is a general term for fibrous silicate minerals of the serpentine and amphibole mineral groups, which are widely distributed throughout the Earth's crust. Six commercially important minerals are generally characterized as asbestos. Chrysotile is the only member of the serpentine group and the form of asbestos that is mined in Canada. The amphiboles include crocidolite, amosite, tremolite, anthophyllite and actinolite.

The chemical nature and crystalline structure of asbestos impart a number of desirable characteristics, including high tensile strength, durability, flexibility and heat and chemical resistance; these properties make the mineral useful for a large number of applications, particularly in construction materials, such as asbestos-cement (A/C) sheet and pipe, electrical and thermal insulation and friction products, such as brake linings. Current world production is about 4.5 million tonnes, of which more than 99% is chrysotile.[1] Canada mines approximately 1.5 million tonnes of chrysotile annually, principally in the province of Quebec.[1] The other varieties of asbestos that are used most widely are amosite and crocidolite.

Asbestos is ubiquitous in the environment as a result of its extensive industrial use and the dissemination of fibres from natural sources.[2] It is introduced into water by the dissolution of asbestos-containing minerals and ores and from industrial effluents, atmospheric pollution and, in some cases, A/C pipe in distribution systems. The contribution of A/C pipe to the asbestos content of water is dependent upon its aggressivity, which varies as a function of pH, alkalinity and water hardness. In a national survey of 71 locations across Canada, erosion of A/C pipe appeared to contribute measurably to the asbestos content of water supplies at only two locations, even though it is used in about 19% of water supplies.[3]

Exposure

Chrysotile was the predominant type of asbestos identified in a survey of drinking water supplies conducted at 71 locations across Canada in 1977; there was little contamination by amphiboles. Using transmission electron microscopy (TEM) with identification by energy-dispersive X-ray analysis and selected-area electron diffraction, chrysotile concentrations ranged from not detectable (<0.1 million fibres/L) to 2000 million fibres/L. In general, median fibre lengths were between 0.5 and 0.8 μm. Based on the results of this survey, which encompassed the water supplies of about 55% of the Canadian population, it was estimated that 5% of the population receives water with chrysotile concentrations higher than 10 million fibres/L and that 0.6% receives water containing more than 100 million fibres/L.[3]

There is also potential for exposure in the home to airborne asbestos released from tap water; however, testing using a conventional drum-type humidifier showed that release of asbestos fibres to air from water containing 40 ±10 million fibres/L was negligible.[4] In Woodstock, NY, where elevated concentrations of asbestos in the drinking water supply (up to 10 billion fibres/L) were attributed to severely deteriorating A/C pipes, it was reported that airborne asbestos concentrations were significantly higher in three "impacted" homes with water containing elevated concentrations of asbestos (17 to 31 million fibres/L) than in three control homes with water containing low concentrations of asbestos (0.15 to 2.6 million fibres/L) (based on determinations of total fibre counts by TEM with microbeam electron diffraction).[5] All airborne fibre concentrations determined in the study were within the range of those measured in indoor and outdoor air in other investigations. Concentrations of airborne fibres longer than 5 μm, which would have been more relevant for assessment of potential risk to health, were not determined;

however, the authors reported that the difference in airborne concentrations between "impacted" and control homes was primarily due to increased numbers of short (<1 μm) fibres in the homes with high waterborne asbestos concentrations. This observation seems inconsistent with the hypothesis that waterborne asbestos in the "impacted" houses was responsible for the significant increase in airborne levels, because fibres in the water supply of these homes, attributable to erosion of A/C pipe, were longer than those in control homes.

The extent of asbestos contamination of solid foodstuffs has not been well studied because of the lack of a simple, reliable analytical method. Foods that contain soil particles, dust or dirt almost certainly contain asbestos fibres. Concentrations of 0.151×10^6 fibres/L have been found in some English beers.[6] Concentrations of 4.3 to 6.6×10^6 fibres/L have been recorded in Canadian beers; in soft drinks, concentrations were between 1.7 and 12.2×10^6 fibres/L.[7]

Only limited data concerning concentrations of asbestos present in the air of Canadian communities are available. Early data were reported in terms of gravimetric concentrations, which are less relevant than airborne fibre concentrations in assessing risk to health. In Canada, based on analysis by analytical TEM with direct sample preparation, mean chrysotile concentrations at 12 Metropolitan Toronto locations ranged from <0.002 to <0.045 fibres/mL. Mean concentrations in 12 other southern Ontario locations ranged from <0.002 to <0.033 fibres/mL. Concentrations at 10 remote rural locations were all below the detection limit of the analytical method used (<0.002 fibres/mL).[8]

Analytical Methods and Treatment Technology

The method of choice for the determination of asbestos in ambient air and water is TEM, with identification by energy-dispersive X-ray analysis and selected-area electron diffraction. However, it is often difficult to make meaningful comparisons of fibre concentrations determined by TEM because of the variations in procedures for sample preparation and analysis used in different laboratories.[9] In addition, results can be reported in terms of fibre numbers or mass concentrations, depending upon the method of sample preparation.

The results of the Canadian survey indicated that standard water treatment processes involving chemical coagulation followed by filtration effectively remove asbestos fibres from drinking water supplies.[3] The ratio of asbestos concentrations in filtered water to those in raw water ranged from 18 to 300 for seven locations, with fibre concentrations in raw water ranging from 6.4 to 190 million fibres/L.[3]

Health Effects

The health hazards associated with inhalation of asbestos in the occupational environment have long been recognized and include asbestosis, bronchial carcinoma, malignant mesothelioma of the pleura and peritoneum and possibly cancers of the gastrointestinal tract and larynx. In contrast, there has been little evidence of the carcinogenicity of ingested asbestos in toxicological and epidemiological studies conducted to date.

In ecological epidemiological studies of populations in Duluth,[10–12] Canadian cities in areas of asbestos deposits,[13,14] Connecticut,[15,16] Florida[17] and Utah,[18] there has been no consistent evidence of an association between cancer mortality or incidence and ingestion of asbestos in drinking water. Although there was evidence of an association in an ecological study in the San Francisco Bay area,[19,20] reanalysis of the data taking potential confounders into account has undermined the significance of these results.[21,22] Moreover, in an analytical epidemiological (case-control) study that was inherently more sensitive than the ecological studies mentioned above, there was no consistent evidence of a cancer risk due to ingestion of asbestos in drinking water in Puget Sound, where levels ranged up to 200 million fibres/L.[23] In this study, the minimum risk that could be detected at the 5% significance level with 80% probability was under 2 for each sex for all study sites combined—digestive system, respiratory system, colon and lung.

There is also no conclusive evidence from studies in animals that ingested asbestos is carcinogenic.[24] The most extensive animal studies conducted to date have been those of the U.S. National Toxicology Program involving treatment groups of 250 animals of each sex.[25–27] No treatment-related increases in tumour incidence were observed in Syrian golden hamsters fed 1% amosite or short-range or intermediate-range chrysotile in the diet over their lifetime. Similarly, no treatment-related effects were observed in Fischer-344 rats fed 1% tremolite or amosite in the diet over their lifetime. The incidence of benign epithelial neoplasms in the gastrointestinal tract in male Fischer-344 rats fed 1% intermediate-range chrysotile (65% longer than 10 μm) was significantly increased in comparison with pooled controls from contemporary lifetime asbestos feeding studies in the same laboratory. However, the increase was not statistically significant in comparison with concurrent controls and was limited to one sex. Moreover, no increase in tumour incidence was observed in Fischer-344 rats ingesting short-range chrysotile (98% shorter than 10 μm) that was composed of fibre sizes more similar to those found in drinking water.

Classification and Assessment

Based on information available in extensive toxicological and epidemiological studies conducted to date, there is no consistent, convincing evidence that ingested asbestos is hazardous to health. There is, therefore, no need to establish a maximum acceptable concentration (MAC) for asbestos in drinking water.

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