Ceramic Fibers (Respirable Size)*

Reasonably anticipated to be a human carcinogen

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Carcinogenicity

Ceramic fibers are *reasonably anticipated to be human carcinogens* based on sufficient evidence of carcinogenicity in experimental animals (IARC 1988). When administered by inhalation, rats of both sexes showed a significant increase in the incidence of benign and malignant tumors of the lung.

No adequate human studies of the relationship between exposure to ceramic fibers and human cancer were found (IARC 1988).

Properties

Ceramic fibers comprise a wide range of amorphous or crystalline, synthetic mineral fibers characterized by their refractory properties (i.e., stability at high temperatures). They are typically made of alumina, silica, and other metal oxides or, less commonly, of nonoxide materials such as silicon carbide. Most ceramic fibers are composed of alumina and silica in an approximate 50/50 mixture. Monoxide ceramics, such as alumina and zirconia, are composed of at least 80% of one oxide, by definition; generally they contain 90% or more of the base oxide, and specialty products may contain virtually 100%. Nonoxide specialty ceramic fibers, such as silicon carbide, silicon nitride, and boron nitride, have also been produced. Since there are several types of ceramic fibers, there is also a range of chemical and physical properties. Most fibers are white to cream in color and tend to be polycrystallines or polycrystalline metal oxides (IARC 1988).

Use

Ceramic fibers are used as insulation materials and are a significant replacement for asbestos. Due to their ability to withstand high temperatures, they are used primarily for lining furnaces and kilns. The products produced are in the form of blankets, boards, felts, bulk fibers, vacuum-formed or cast shapes, paper, and textile products. Their light weight, thermal shock resistance, and strength make them useful in a number of industries. High-temperature resistant ceramic blankets and boards are used in shipbuilding as insulation to prevent the spread of fires and for general heat containment. Blankets, rigid board, and semirigid board can be applied to the compartment walls and ceilings of ships for this purpose. Ceramic blankets are used as insulation for catalytic converters in the automobile industry and in aircraft and space vehicle engines. In the metal industry, ceramic blankets are used as insulation on the interior of furnaces. Boards are used in combination with blankets for insulation of furnaces designed to produce temperatures up to approximately 1,400°C. Ceramic boards are also used as furnace and kiln backup insulation, thermal covering for stationary steam generators, linings for ladles designed to carry molten metal, and cover insulation for magnesium cells and high temperature reactors in the chemical process industry. Ceramic textile products, such as yarns and fabrics, are used extensively in such end-products as heat-resistant clothing, flame curtains for furnace openings, thermocoupling and electrical insulation, gasket and wrapping insulation, coverings for induction-heating furnace coils, cable and wire insulation for braided sleeving, infrared radiation diffusers, insulation for fuel lines and high-pressure portable flange covers. Fibers that are coated with Teflon® are used as sewing threads for manufacturing high-temperature insulation shapes for aircraft and space vehicles. The spaces between the rigid tiles on space shuttles are packed with this fiber in tape form (IARC 1988).

Production

Although production of ceramic fibers began in the 1940s, their commercial exploitation did not occur until the early 1970s. World-wide production of ceramic fibers in the early-to-mid 1980s was estimated at 154 to 176 million lb, with U.S. production comprising approximately half that amount. With the introduction of new ceramic fibers for new uses, production has increased significantly over the past decade. Ceramic fibers are produced by blowing and spinning; colloidal evaporation, continuous filamentation, and whisker-making technologies (vapor-phase deposition) are used to a lesser extent, mainly for special applications (IARC 1988).

Exposure

The primary route of potential human exposure to ceramic fibers is by inhalation, mainly during its manufacture and formulation. Manufactured mineral fiber products release airborne respirable fibers during their production and use. Ceramic fibers are being produced in increasingly large quantities for high temperature insulation and in specialty products. The upper diameter limit for respirable fibers is considered to be either 3 µm or 3.5 µm. Fiber concentrations during ceramic fiber production in the United States were higher than those in glass wool and continuous glass filament facilities, but were comparable with exposures to airborne fibers in rock wool and slag wool facilities. Approximately 90% of airborne fibers in three facilities were determined to be respirable (i.e. less than 3 µm in diameter), and approximately 95% were less than 50 µm in length. There are three primary situations in which the workplace population is exposed to potential contact with refractory ceramic fibers: the manufacturing environment, during installation, and during removal (TIMA 1990). Exposure to refractory ceramic fibers by the general public (e.g. in consumer appliances) would be minimal, as these products are generally encapsulated, minimizing exposure potential if any exists. A projection of the number of U.S. workers potentially exposed to refractory ceramic fibers is approximately 32,300 workers. In the United States, the typical workday of an insulation installer included about 4 hours of actual installation. Measurements have been made of exposures during production of aircraft insulation and installation of duct insulation, acoustical ceilings, attic insulation, building insulation, and duct systems. The results indicate that exposures of users may exceed those of production workers (IARC 1988).

Regulations

No regulations relevant to reduction of exposure to ceramic fibers were identified.

Guidelines

ACGIH

Threshold Limit Value - Time-Weighted Average Limit (TLV-TWA) = 0.2 respirable fibers/cc (refractory ceramic fibers)

*No separate CAS registry number is assigned to ceramic fibers.

References

IARC. 1988. Man-made Fibers and Radon. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans, vol. 43. Lyon, France: International Agency for Research on Cancer. 300 pp.

TIMA. 1990. Health and Safety Aspects of Man-Made Vitreous Fibers: Information, Data, Comments and Recommendations Regarding Occupational Exposure to Man-Made Vitreous Fibers. Thermal Insulation Manufacturers Association.