Health and Safety Aspects of Refractory Fibers

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Refractory fiber is an important member of a family of fibrous products known collectively as man-made vitreous fibers (MMVF) because of their synthetic amorphous, glassy nature. These products share a common manufacturing origin in that they are all created from molten masses of raw materials under highly controlled conditions. This group includes glass fiber, rockwool (mineral wool or slag wool), glass microfiber and alumina-silica refractory fiber such as Manville's Cerawool fiber, Cerafiber and Cerachrome fiber products.

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The health and safety aspects of man-made vitreous fibers as a group have been studied extensively in the U.S. and in Europe with particular emphasis on glass fiber and rockwool fiber. Large scale epidemiological studies and animal inhalation studies have demonstrated that there is no credible evidence of long term health effects attributable to exposure to these fibers. A detailed discussion of the above information is available as a separate Manville publication.*

Aluminum silicate refractory fiber is the newest member of the MMVF family and has only been produced in large quantities for about 25 years. Because of this relatively short history, we feel that it is necessary to establish through testing whether or not the health effects of these fibers are identical to those reported for glass and rockwool fibers. The refractory fiber industry, through the auspices of the Thermal Insulation Manufacturers Association, is sponsoring animal inhalation studies as well as epidemiological studies of workers in the industry. Until such time as definitive answers are available, it will be advisable to follow certain common sense work practices designed to minimize exposure. These recommendations, as well as the associated rationale, will be covered in appropriate sections of this publication.

Refractory fiber and most glass fibers are very similar in their ability to cause skin and upper respiratory irritation. *SKIN IRRITATION* is experienced by some workers in refractory fiber manufacturing facilities as well as some people working with refractory fiber-containing materials. This skin irritation and possible inflammation is a mechanical reaction due to sharp, broken ends of fiber that rub or become embedded in the outer layer of the skin. Skin reactions vary directly with the size and the stiffness of the fiber handled, with fibers of large diameter (greater than 5 micrometers) being more likely to cause irritation and itching. Irritation normally does not persist for any length of time and can be relieved by washing exposed skin areas gently in warm water with mild soap.

Some individuals may be more sensitive to irritation from refractory fiber than are others, and a relatively small number may be forced to seek other types of employment. The vast majority of workers, however, can control skin irritation by following the work practices outlined at the end of this bulletin.

It is possible that some workers may experience temporary *UPPER RESPIRATORY IRRITATION* (that is, scratchiness or burning of the nose or throat) if considerable amounts of airborne refractory fiber are generated during manufacture or handling of refractory fiber-containing products. Like skin irritation, upper respiratory irritation is a mechanical reaction to sharp, broken fibers. It is not an allergic reaction and the irritation does not persist.

Accidental exposures to high concentrations of airborne refractory fiber may produce a transitory condition, usually manifested by a coughing or wheezing. Careful attention to housekeeping and proper work practices can effectively control airborne refractory fiber concentrations to prevent this upper respiratory irritation. The effects subside soon after the worker is removed from exposure and have no known long-lasting impact on health.

Alumina-silicate refractory fiber which has been in service at elevated temperatures (greater than 2000°F) may undergo partial conversion to cristobalite, a form of crystalline silica which can cause respiratory disease. This is a consequence of the crystallization or devitrification of the fibers which occurs at high temperatures. The amount of cristobalite which is formed, the size of the individual crystallites and the nature of the

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matrix in which they are embedded are all a function of the temperature and the length of time the fiber has been heated.

Although animal experiments have not yet been conducted to ascertain whether or not these devitrified fibers are biologically active, the most prudent approach is to treat them as free crystalline silica. Under normal use conditions, refractory fiber will generally be exposed to a temperature gradient. Consequently it is most probable that only the fiber nearest the hot surface will have an appreciable cristobalite content. It is also possible that the devitrified cristobalite-containing fiber will be more friable and therefore may generate a larger amount of dust when fiber is removed from a high temperature furnace.

Particular care should be taken during the "tear-out" of refractory fiber linings to minimize generation of dust. Adherence to proper methods of dust suppression and control is imperative. Even with adequate control, we recommend that a respirator approved by NIOSH for protection against pneumoconiosis-producing dusts be used by all workers in the area during a lining removal operation, such as the 3M brand Dust Respirator 8710. This mask provides adequate protection against dusts, is lightweight and disposable.

Medical and Scientific Studies

Experimental studies in which refractory fibers were surgically implanted in the pleural (chest) and abdominal cavities of laboratory animals have demonstrated that response is no different from all other fibrous materials. Fibers which have diameters less than 1.5 micrometers and lengths greater than 10 micrometers can induce tissue changes, including cancer. In these experiments, however, all of the animals' normal defense mechanisms have been bypassed.

In contrast to the above, full scale inhalation experiments in which the animals were exposed to dust clouds containing high concentrations of very fine diameter glass fibers did not result in the production of any adverse reactions in the lung tissue. Similar experiments are now underway with refractory fiber. This study is part of the large scale effort by the Thermal Insulation Manufacturers Association (TIMA) to obtain medical/scientific information on the entire family of MMVF. This experiment will be completed in early 1986. The results will be made available to the industry soon thereafter.

Plans are also being formulated to initiate a long term epidemiological study on the effects of occupational exposure to refractory fibers on the health of workers in the industry.

Recommended Handing Procedures

In April 1977, the U. S. National Institute for Occupational Safety and Health (NIOSH) published a criteria document on occupational exposure to fibrous glass. Although their conclusions are based on data from the fibrous glass and rockwool industries, it has been assumed that the same recommendations would apply to refractory fibers as well.

The criteria document recommended that the U. S. Occupational Safety and Health Administration (OSHA) adopt an occupational exposure standard limiting exposure to 3 fibers per cubic centimeter (f/cc), composed of fibers less than 3.5 micrometers in diameter and greater than 10 micrometers in length. OSHA has not yet acted on this recommendation and there is no indication that the agency will do so in the near future. One important reason for OSHA not adopting the recommended standard is that industrial hygiene measurements show that the airborne fiber concentrations in the glass fiber industry are normally very much lower.

OSHA presently classifies man-made vitreous fibers as a nuisance dust, with a workplace permissible limit of 30 million particles per cubic foot of air as determined by the impinger method of monitoring, or 5 milligrams per cubic meter of air as determined by the respirable gravimetric method.

Industrial hygiene data, obtained on a regular basis at all Manville locations where refractory fiber products are manufactured, show that the dust concentrations are well below the 3 f/cc recommended limit as well as below the current OSHA standard of 5 milligrams per cubic meter of respirable dust.

According to the American Conference of Governmental Industrial Hygienists, exposure limits "refer to airborne concentrations of substances," time weighted for a 7- to 8-hour workday and 40-hour workweek, and "represent conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect."

Industrial hygiene data for refractory fiber handling obtained under typical field conditions indicate that in confined areas with poor exhaust ventilation, it would be possible to exceed the NIOSH recommended limit of 3 f/cc. In such situations temporary exhaust ventilation should be installed. If this is not feasible, adequate respiratory protection of the type suggested in the following recommended work practices should be provided.

Recommended Work Practices

Loose Clothing. Wearing long-sleeved shirts and blouses, loose at the neck and wrists, along with long pants and caps will protect skin areas from coming in contact with refractory fiber. Loose clothing also helps prevent fiber from rubbing into the skin. Depending on job conditions, gloves may be necessary.

Minimize Dust. Mechanical dust collection systems should be used whenever refractory fiber materials are machine sawed or sanded. Handling and cutting should be done in a manner that will create the least amount of airborne dust.

Skin Irritation. If refractory fiber particles accumulate on exposed skin areas, do not rub or scratch. Remove the particles by washing the skin thoroughly but gently with warm water and mild soap. Using a good commercial skin cream or lotion after washing may be helpful.

Eye Protection. Safety glasses, goggles, or face shields should be worn whenever refractory fiber materials are being applied overhead or in areas where loose particles may get into the eyes.

Respirators. If there is a possibility that airborne concentrations may exceed recommended maximum levels, or if respiratory discomfort is experienced, respiratory protective equipment should be worn. Acceptable respirators are those specifically approved by NIOSH for protection against nuisance dusts, such as the 3M respirator model 8710 or its equivalent. Take the time to make certain the respirator fits properly before using it. Respirators must be worn when refractory fiber is removed after service at high temperatures.

Washing Work Clothes. Work clothing worn in areas where exposure to refractory fiber is possible should be washed separately from other household laundry to prevent fiber from being transferred to other clothing. Rinse the washing machine thoroughly before it is used again. If there is a lot of fiber on clothing, it is best to presoak and rinse the garments first, prior to washing.

Housekeeping. Avoid unnecessary rehandling of scrap materials by keeping waste disposal equipment as close to working areas as possible. Don't let scrap material and debris pile up on floors and other surfaces. Follow an organized housekeeping program at all times.

Summary

Extensive studies on the health effects of man-made vitreous fibers have shown that occupational exposure, under normal conditions of manufacture or utilization, does not lead to any adverse health effects. Refractory fiber, however, has only been produced in large quantities for a limited time and more data are needed to firmly establish that they, too, are free of problems. Until such data are available, it is recommended that the fiber concentration in the workplace be controlled at or below the NIOSH recommended level of 3 f/cc.

The presence of cristobalite in refractory fibers which have been in service at high temperatures does represent a potential health hazard because of the exposure to free crystalline silica. It is, therefore, recommended that workers involved in the removal of used refractory fibers be provided with adequate respiratory protection. Respirators approved by NIOSH for protection against pneumoconiosis-producing dusts, such as free crystalline silica, should be used.

The skin and upper respiratory irritation which may be experienced by some workers can be minimized or eliminated by observing the recommended work practices.