

# REFRACTORY CERAMIC FIBRES



## TABLE OF CONTENTS

What are refractory ceramic fibres (RCFs)?	1
Where are RCFs found in the workplace?	1
What happens to RCFs after use in high temperatures?	1
How can a worker be exposed to RCF?	1
What are the health effects of RCF?	2
How can RCFs exposure be controlled in the workplace?	3
What is the workplace exposure limit for RCFs?	3

**WHAT ARE REFRACTORY CERAMIC FIBRES (RCFS)? REFRACTORY CERAMIC FIBRES (CAS #142844-00-6) ARE A SPECIAL CATEGORY OF SYNTHETIC VITREOUS FIBRES (SVFS, OR, MORE COMMONLY KNOWN AS MAN-MADE MINERAL FIBRES (MMMFS)).** Refractory ceramic fibres (RCFs) were first commercially produced in 1953. RCFs make up 1-2% of the worldwide production of SVF. They are sold under the trade names: Fiberfax, Cerwool, Kaowool, and others.

There are three basic kinds of RCFs:

- kaolin or clay-based products, where the clay is obtained in mining;
- blends of alumina and silica with metal oxide additives (chromium (2-3%), zirconium (15-25%));
- high-purity blends of silica and alumina.

RCFs are either blown or spun from molten clay (kaolin), or, molten alumina and silica mixtures (roughly 50% each). The diameters of fibres produced are usually between 1-3 microns or micrometers ( $1\mu\text{m} = 0.001\text{ mm}$ ). Raw RCFs usually look like a white or gray fibrous material supplied in bulk fibre, or blanket form. They can also be part of solid products such as cast refractories used as insulation for furnaces.

The silica part of the final product is not crystalline silica, rather the silica molecule has been combined with the alumina to form an alumino-silicate. After use in high temperature applications the silicate may be transformed into crystalline silica (*cristobalite*) if the temperature is high enough (greater than 1000°C).

## WHERE ARE RCFS FOUND IN THE WORKPLACE?

There is only one producer of RCFs in Canada so the bulk of the RCFs used in industry are imported from the US. There are a number of factories that take bulk RCF and manufacture it into a product to be sold to other industries. The vacuum forming of refractory materials is a common RCF process. Ceramic fibres can also be mixed with other refractory materials and cast into specific shapes. Some RCFs are woven into textiles for fire prevention or insulation.

RCF containing manufactured products can be found in the steel, petrochemical, ceramic, automotive and primary metal industries. They are mainly used for insulation; reinforcement; and fire protection for furnaces, heaters, kiln linings, furnace doors and other high-temperature uses (*up to 1425°C*). Some of the newer RCF applications include car parts (*catalytic converters, metal reinforcement, heat shields, brake pads*) and in the aerospace industry (*heat shields*).

## WHAT HAPPENS TO RCFS AFTER USE IN HIGH TEMPERATURES?

At high temperatures (*above 1000°C*) the silica in the RCF changes into a particular form of crystalline silica called cristobalite. It has been suggested that cristobalite starts to form after 3000 hours at 1100°C, 300 hours at 1200°C, and 50 hours at 1300°C, however, actual rates of transformation will vary from application to application.

## HOW CAN A WORKER BE EXPOSED TO RCF?

The situations in which a worker can be exposed to RCF are: during the manufacture, processing, installation, and removal of RCFs or RCF containing products.

RCFs get into the body primarily by breathing in fibres. In order to be of concern, the fibres must be thin enough ( $<5\mu\text{m}$  in diameter) to penetrate the lungs defenses to get to the sensitive areas of the lungs where oxygen gets absorbed in the blood. The lung has difficulty removing long thin fibres and thus has to wait until they

break into smaller pieces or dissolve. For RCFs this process of removal from the lungs can take longer than for fibreglass fibres and other SVFs but it takes less time than for asbestos. Fibres removed from the lungs by the lung's defense system (*by coughing up and swallowing*) will find their way into the digestive tract.

Skin and eye surface contact is another way workers can be exposed to RCFs. Contaminated skin and work clothing can lead to further inhalation and/or ingestion exposure.

## WHAT ARE THE HEALTH EFFECTS OF RCF?

The most readily experienced health effect associated with RCF exposure is skin, eye, nose, and throat irritation. This irritation can be caused by simple mechanical irritation or it may be as a result of a reaction to a chemical coating applied to the fibre during the manufacturing process.

When removing used RCF insulation and refractory material from high temperature applications (*above 1000°C*), inhaling crystalline silica is a concern. Repeated high exposures over many years can lead to silicosis. Silica is a recognized cause of lung cancer.

Another major long-term health concern with RCFs exposure is the possibility that these fibres can cause the same health effects as asbestos. Researchers have found that asbestos-related health effects are due to the shape and durability of the asbestos fibre. Small diameter ( $<5 \mu\text{m}$ ) and long ( $>5-10 \mu\text{m}$ ) fibres which remain in the body for a long time (*months to years*) seem to carry the greatest health risks. Thus, if another kind of fibre has the same shape as an asbestos fibre and remains in the lungs for a long time, one can expect similar health effects. RCFs, probably more than any other SVF seem to fit these criteria. While the diameters of RCFs are larger than asbestos fibre diameters, they are still small enough to find their way into the lungs. RCFs are also quite durable in the body (*not as durable as asbestos however*).

Animal experiments were carried out in order to test whether RCFs could cause similar effects as asbestos. The

results of these tests carried out by the manufacturers of RCF found that asbestos type health effects occurred in the test animals: cancer of the lining of the lung (*mesothelioma*), cancer of the lung, scarring of the lungs and the lining around the lungs. In fact in some experiments the health effects on the animals were more severe for RCFs than for chrysotile asbestos. Not all the animal species tested showed the same rates of health effects and most studies only found effects at high exposure levels (*higher than normally experienced in the workplace except for some furnace insulation tear-outs*). Despite these reservations about the animal studies, all researchers agree that RCFs can cause asbestos type health effects in animals.

Once it was realized that high exposures to RCFs might be associated with asbestos type health effects, the next logical question is what about the health of exposed workers? To date very few studies have been performed. One on-going study of workers in an RCF manufacturing plant found up to 20% of workers had chest X-rays that showed effects on the lining of their lungs (*pleural plaques*) which is usually interpreted as a tell-tale sign of asbestos exposure. Other industry-based studies have shown drops in lung function over the years.

OHCOW is aware of only one study sponsored by the Refractory Ceramic Fiber Coalition (*an industry group*) which has looked at the cancer rates among RCF exposed workers. Very early results are showing no mesotheliomas and no excess lung cancer to date, however, the results thus far are very early. Industry projections of the risk suggest that a cancer effect cannot yet be ruled out, however, it is less potent than amosite asbestos but cannot be proven yet to be less potent than chrysotile asbestos.

Despite the lack of studies on RCF exposed workers, the Canadian Environmental Protection Agency (1993) classified RCFs as probably carcinogenic to humans (*Group II*) based on the animal evidence alone. Similarly, the International Agency for Research on Cancer classifies RCFs as a possible carcinogen (*group 2B*). The American Conference of Governmental Industrial Hygienists (ACGIH) has an A2 designation (*suspected human carcinogen*) for RCFs.

## HOW CAN RCFS EXPOSURE BE CONTROLLED IN THE WORKPLACE?

Studies have determined that it may be not practical to substitute RCFs with any other type of fibre in furnace insulation applications (*where RCFs were used originally as a substitute for asbestos*). In other applications substitutes for RCFs may be available.

If RCFs cannot be eliminated from the workplace by substitution, then engineering controls are the best way of controlling workplace exposures. Either the process or the worker can be isolated/enclosed so that any exposure is essentially prevented from entering the breathing zone of workers.

If isolation or enclosure (*at the source*) doesn't work, local exhaust ventilation is the next option in preventing exposure. Capturing the dust as close as possible to the source of the emission point is the most effective ventilation strategy for preventing exposure.

Where ventilation cannot be effectively used personal protective equipment (*PPE*) may be required as the last line of exposure prevention.

Air monitoring should be conducted periodically to ensure workers are being protected. Since there are no specific exposure limits for RCF in Ontario, the ACGIH has an 8-hour TLV of 0.2 f/cc (*fibres per cubic centimeter of air*) should be used as a guideline. Workers exposed to RCFs should be provided with information, instruction and training on health effects of RCFs, exposure prevention strategies, safe working procedures and hygiene practices.

Given that the evidence so far suggests RCFs have health effects similar to that of asbestos, it is recommended that asbestos-type exposure precautions be used when handling RCFs.

## WHAT IS THE WORKPLACE EXPOSURE LIMIT FOR RCFS?

The current Ontario Regulation respecting Control of Exposure to Biological or Chemical Agents – made under the Occupational Health & Safety Act has no specific reference to refractory ceramic fibres. The RCF industry has argued that the appropriate standard should be 0.5 f/cc (*8-hour TWA*). The province of Alberta has established an exposure limit of 0.5 f/cc (*8-hour TWA*). The ACGIH has an exposure limit (*TLV or Threshold Limit Value*) for refractory ceramic fibres to 0.2 f/cc, with an A2 designation (*suspected human carcinogen*).

## REFERENCES

ACGIH. 2003 TLVs and BEIs , 2003

ACGIH. Synthetic Vitreous Fibers. In: *Supplements to the Sixth Edition, Documentation of the Threshold Limit Values and Biological Exposure Indices*, 1998.

Bunn WB; Chase GR; Hesterberg TW; Versen RA; Anderson R. 111. Manmade Mineral Fibres. In: *Hazardous Materials Toxicology – Clinical Principles of Environmental Health*. Editors: John B. Sullivan, Jr., M.D. and Gary R. Krieger, M.D., M.P.H. Williams & Wilkins, 1992.

Lockey JE; Ross CS. Health Effects of Man-Made Fibres. In: *Encyclopedia of Occupational Health and Safety, 4th Edition*. Editor-in-Chief: Jeanne Mager Stellman, PhD. International Labour Office, Geneva. 1998.

LeMasters GK, Lockey JE, Yiin JH, et al. "Mortality of Workers Occupationally Exposed to Refractory Ceramic Fibers" *J Occup Environ Med*. 45:440-450 (2003)

Mast RW; Utell MJ. Chapter 15. Man-Made Vitreous Fibers. In: *Occupational Medicine, Third Edition*. Editor-in-Chief: Carl Zenz, M.D., Sc.D. Mosby, 1994.

Maxim LD, Yu CP, Oberdorster G, and Utell MJ. "Quantitative Risk Analyses for RCF: Survey and Synthesis" *Reg Tox Pharm* 38:400-416 (2003)

National Occupational Health and Safety Commission [Australia] (1990): Synthetic Mineral Fibres. National Standard for Synthetic Mineral Fibres. *National Code of Practice for the Safe Use of Synthetic Mineral Fibres*. Australian Government Publishing Service: Canberra.

Steenland K, Mannetje A, Boffetta P, et al. "Pooled Exposure-Response Analyses and Risk Assessment for Lung Cancer in 10 Cohorts of Silica-Exposed Workers: An IARC Multicentre Study" *Cancer Causes and Control* 12:773-784 (2001)

Vanden Bergen EA, Rocchi PSJ, and Boogaard PJ. "Ceramic Fibers and Other Respiratory Hazards During the Renewal of the Refractory Lining in a Large Industrial Furnace" *Appl Occup Environ Hyg* 9:32-35 (1994)

Wiese NK; Lockey JE. Chapter 22. Man-Made Vitreous Fiber, Vermiculite, and Zeolite. In: *Environmental and Occupational Medicine*. Editors: William N. Rom, M.D., M.P.H. Little, Brown and Company, 1992.

## OHCOW OFFICES

If you need further assistance, call the Occupational Health Clinic for Ontario Workers Inc. Closest to you.

### HAMILTON

848 Main Street East  
Hamilton, ON  
L8M 1L9  
(905)-549-2552  
Toll Free: 1-800-263-2129  
Fax: (905)-549-7993  
E-mail: hamilton@ohcow.on.ca

### SARNIA-LAMBTON CLINIC

171 Kendall Street  
Point Edward, ON  
N7V 4G6  
(519)-337-4627  
Fax: (519)-337-9442  
E-mail: sarnia@ohcow.on.ca

### SUDBURY

1300 Paris St.  
Suite 4  
Sudbury, ON  
P3E 3A3  
(705)-523-2330  
Toll Free: 1-800-461-7120  
Fax: (705)-523-2606  
E-mail: sudbury@ohcow.on.ca

### TORONTO

970 Lawrence Ave. West  
Main Floor  
Toronto, ON  
M6A 3B6  
(416)-449-0009  
Toll Free: 1-888-596-3800  
Fax: (416) 449-7772  
E-mail: toronto@ohcow.on.ca

### WINDSOR

3129 Marentette Avenue  
Unit #1  
Windsor, ON  
N9A 4N1  
(519)-973-4800  
Toll Free: 1-800-565-3185  
Fax: (519)-973-1906  
E-mail: windsor@ohcow.on.ca

### PROVINCIAL OFFICE

15 Gervais Drive  
Suite 601  
Don Mills, ON  
M3C 1Y8  
(416)-443-6320  
Fax: (416)-443-6323  
Toll Free : 1-877-817-0336  
E-mail: info@ohcow.on.ca

Every effort has been made to ensure the accuracy of the information in this workbook.  
OHCOW assumes no responsibility for how this information is used.

Revised February 2004