Crystallisation: Crystalline silica in after use fibre

Some users have expressed concern about possible health effects associated with crystalline silica, which may be formed when certain low bio-persistent (Superwool®) fibres are heated to temperatures above 900°C (1652°F). It should be noted that whilst all high temperature insulation wools undergo a crystallisation process at high temperatures, our patented low bio-persistent Superwool XTRA is the only fibre chemistry that does not form crystalline silica.

This fact sheet therefore focuses on work carried out on low bio-persistent Alkaline-Earth-Silicate (AES) fibre (Superwool Plus, Superwool HT and Superwool 607 Max) chemistries as well as refractory ceramic fibre. It aims to present a clear answer to these concerns, including information from a body of independent testing, which was completed by the Fraunhofer Institute for Experimental Medicine (ITEM) in 2006 and Heriot Watt University in 2017. These studies show that both low bio-persistent AES Superwool and refractory ceramic fibres, when crystallised by heating under conditions which promote the formation of crystalline silica, display no hazardous activity related to any silica they may contain. These results, coupled with the very low crystalline silica exposures measured during furnace maintenance and wrecking, means that there is unlikely to be any risk of crystalline silica related diseases resulting from employment in these activities.

What is Crystalline Silica?
In our everyday lives, all of us are exposed to materials containing crystalline silica which may generate dust and suffer no ill effects as a result.

- Silica is synonymous with silicon dioxide (SiO2). Silica is commonly found in nature as sand.
- Quartz is the most common form of crystalline silica and is the second most common mineral on the earth's surface. It is found in almost every type of rock i.e. igneous, metamorphic and sedimentary.

Why are regulators concerned about Crystalline Silica?
There is a body of evidence showing that exposure to silica which is fine enough to enter the lung (respirable crystalline silica) has the potential to cause disease in specific industrial situations. Examples are the silica dust produced during mining, quarrying, stone masonry and sand blasting, which can cause various lung diseases including silicosis and lung cancer. These are processes where freshly cleaved quartz silica are produced, normally in high energy grinding operations.

What happens to vitreous fibres during use?
When vitreous fibres, including both RCF and low bio-persistent AES Superwool, are heated during use, they will start to crystallise. In this case the components present in the glassy structure may rearrange, allowing various crystalline compounds to form within the fibre. The exact nature of these compounds will depend on the type of fibre and the temperature cycle that the fibres experienced. Crystalline silica is usually one of the forms produced, but it is embedded within the fibre and is not the main crystalline form.

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In a typical furnace application, devitrification will occur only in the layer nearest to the hot face of the insulation and so the fibres concerned normally represent a small part of the complete furnace lining.

What work has been carried out to assess after service fibres for differences in toxicity?

Attempts to measure crystalline silica in the air during furnace wrecking often fail, as the levels are too low to be detectable. This information offers some degree of reassurance; however it was the view of Morgan Advanced Materials that direct testing of heated low bio-persistent AES Superwool® fibres was also necessary to ensure that the dust produced during furnace wrecking did not show any effects similar to those associated with free crystalline silica.

Progressive crystallization of HT fibres after exposure to high temperatures. Crystals form within the fibre.

There is limited evidence for animal studies carried out in the 1980's that after service RCF was less potent than the as made samples tested. This was confirmed by a second group of independent scientists in Edinburgh found this sample to be inert when injected into rats[1].

These early results with RCF already gave an indication that crystallised end of life fibres did not constitute a health hazard.

There are ethical and legal reasons for trying to avoid further experimentation on live animals, and so Morgan Advanced Materials was keen to undertake further tests on low bio-persistent AES Superwool fibres using proven "in-vitro" techniques. It is well known that toxic forms of crystalline silica have been found both to kill macrophages (scavenger cells responsible for removing foreign material from the lungs) and other cells in-vitro as well as causing disease in animals. The investigations chosen focused on observing the effect of heated low bio-persistent AES Superwool fibres on macrophage and epithelial cells. The studies were designed to quantify any effect produced by the low bio-persistent AES Superwool fibre, and investigate any similarities to that produced by a known toxic form of crystalline silica.

The standard active quartz sample (DQ12) was clearly positive in all assays; however, none of the heated fibres showed significant silica activity.

We can conclude that heated low bio-persistent AES Superwool fibres display no hazardous activity related to any silica they may contain. This result, coupled with the very low crystalline silica exposures during furnace maintenance and wrecking, means that there is unlikely to be any risk of crystalline silica related diseases from employment in these activities.

1 Miller BG, Searl A, Davis JMG, Donaldson K, Cullen RT, Bolton RE, Buchanan D, Soutar CA 1999 Influence of fiber length, dissolution and low biopersistence on the production of mesothelioma in the rat peritoneal cavity Ann Occup Hyg; 43:155-66

For all enquiries, please contact our specialist sales and marketing offices:

Americas	Asia	Europe
marketing.tc@morganplc.com	asiasales@morganplc.com	marketing.tc@morganplc.com

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www.morganthermalceramics.com
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