Silica and the lung

What is silica?

Silica is a mineral found in the earth's crust. The crystalline form of silica which is called quartz has been associated with a variety of diseases primarily affecting the lung. Crystalline silica is therefore present in the aggregate added to concrete, in asphalt, bricks, concrete, concrete and terracotta tiles and pavers, in sandstone and in granite. Small amounts are present in cement. Silica can be released if using power tools to cut fibre cement sheeting.

Construction or building material	Amount of crystalline silica (quartz)
Sand and sandstone	96 -100 %
Calcium-silicate bricks	50 - 55%
Aggregate in concrete	30%
Clay bricks	15 - 27%
Fibre cement sheets	10 - 30%
Demolition dust	3 – 4%

Table 1: Typical concentrations of crystalline silica in building materials

How does silica get into the lung?

Airborne silica dust is generated when you chase or drill into concrete, rip up old concrete or bitumen roads, jackhammer or saw old concrete, excavate sites with sandstone, clay or granite or generally get exposed to airborne dust on a construction site. Particles of silica dust can be very fine and as small as one to six microns (millionths of a metre) in diameter.

We breathe and exhale them. Our lungs have scavenger cells called macrophages (see Figure 2). These cells dissolve dust particles by surrounding them. But if there is too much dust, an overload situation, the scavenger cells cannot completely clear the dust. Scarring is the lung's reaction to dust which gets deposited in the air sacs. When there is a lot of scarring you can get shortness of breath.

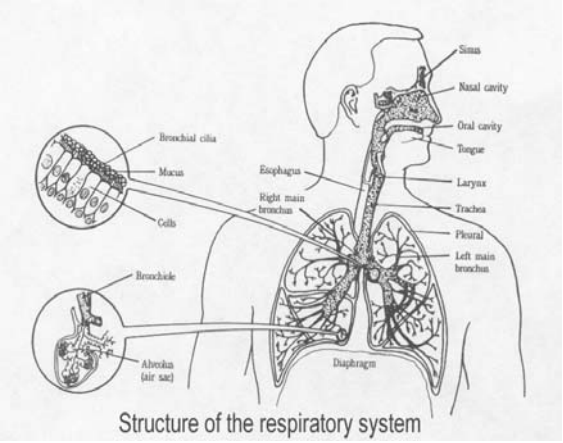

Figure 1: The lung

Figure 2: Lung scavenger cell

What diseases does exposure to crystalline silica cause?

Crystalline silica exposure can cause:

- chronic bronchitis – inflammation of the airways resulting in cough and irritation
- emphysema – destruction of the lung tissue and loss of surface area for the exchange of gases such as oxygen and carbon dioxide
- acute silicosis – extremely high dust exposures after just a few months or years can result in severe inflammation and an outpouring of protein into the lung
- silicosis – scarring of the lung tissue causing shortness of breath and interfering with the exchange of gases which takes place in the air sacs – usually requires 10 or more years exposure unless the dust concentration is very high (see Figures 3, 4 and 5)
- lung cancer – occurs with heavy exposure to silica but smokers have a higher risk
- kidney damage – may require dialysis if severe
- scleroderma – a disease of the connective tissue of the body resulting in the formation of scar tissue in the skin, joints and other organs of the body – pins and needles in the hands can be a symptom.

Figure 3 Chest X-ray showing nodular silicosis

Figure 4: Chest X-ray showing progressive massive pulmonary fibrosis (scarring)

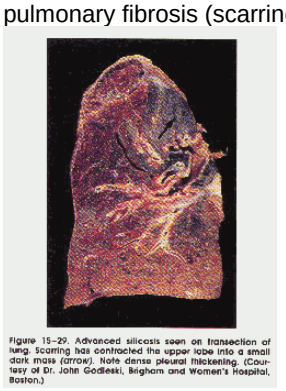

Figure 5: Section of lung with advanced silicosis at autopsy

How do I know if I have silicosis?

In the early stages, silicosis causes no symptoms. It usually takes decades of breathing in quartz-containing dust to develop silicosis. However, there is a disease called acute silicosis which can occur after only a few months to years of breathing in very high concentrations of quartz.

What are the symptoms of silicosis?

The first symptoms of silicosis are often shortness of breath on exertion, a cough, occasional chest pain, loss of appetite and minor fatigue. As the disease progresses, the shortness of breath gets worse on minor exertion and can be present all the time, the cough is more severe and persistent, the chest pain can worsen, and there is associated fatigue, weight loss and night

sweats. Workers with silicosis are more at risk of getting tuberculosis (TB) and lung cancer. The disease can be detected by a chest X-ray in the early stages before symptoms develop. There is no cure for silicosis and therefore prevention is the only option.

Do I need a chest X-ray?

If it is more than 10 years since you first came into contact with silica dust, and you think you have had regular and high exposure, see your doctor to discuss what tests are appropriate. Generally those most at risk are workers who have had extensive exposure to chasing, overhead drilling, and grinding for many years and without any protective measures such as vacuum bag attachments, water or a dust mask.

If your employer's risk management process for the job shows that health monitoring is required, you should be reviewed by a registered medical practitioner[1] and complete a respiratory symptom questionnaire, have testing which may include lung function tests (see Figure 6) and a chest X-ray. The registered medical practitioner will decide what tests are required based on your exposure history.

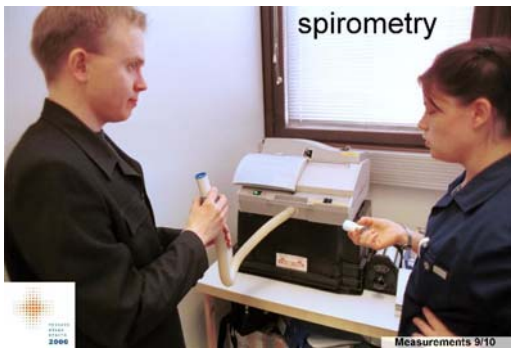

Figure 6: Lung function testing

[1] A registered medical practitioner is a doctor who will have experience in health monitoring and can conduct silica health monitoring.

What are typical exposures to silica in the building and construction industry?

The Safe Work Australia[2] Exposure Standard for respirable crystalline silica is 0.1 mg/m^3, measured in the dust sampled according to a specified lung penetration curve. This means that most people whose exposures are maintained less than 0.1 milligrams of crystalline silica dust in each cubic metre of air, eight hours a day, 48 weeks a year for a working lifetime have a low risk of getting silica-related disease.

The risk of silica-related lung disease can be virtually eliminated in workers who control the dust and wear respiratory protection.

How much silica am I exposed to?

Data collected by researchers in Western Australia and in the Netherlands in typical construction jobs is summarised below:

Activity	***Respirable Silica (quartz) mg/m^3***
Overhead drilling	0.15
Chasing	60.0
Drilling holes in brick or concrete	0.18 – 0.37
Cleaning (sweep/vacuum)	0.03
Dismantling equipment (scaffolding used by bricklayers)	0.1
Demolition - jack hammering	0.25
Tuck pointers chasing mortar	0.56
Background dust	0.03 – 0.05
National Exposure Standard	**0.1**

Table 2: Respirable silica dust concentrations

Who is at risk?

From 1992 - 2004 there were six workers' compensation claims for silicosis in Queensland. Four of these claims were in mining and quarrying, two were in clay, brick and concrete manufacture. It is not clear whether there is little disease due to silica

[2] Safe Work Australia is the Federal agency responsible for harmonising regulations in health and safety. This includes setting exposure standards for chemicals at work.

exposure or whether the disease is simply not diagnosed because of the lack of health monitoring (which includes chest X-rays and lung function tests).

High risk jobs exist in the construction industry and workers at risk of silicosis are largely employed as excavators, jackhammer operators or abrasive blasters. Silicosis results in shortness of breath and people are usually diagnosed when they are near retirement. It is therefore essential to prevent disease by not exposing workers to silica dust to preserve their quality of life in retirement.

Any person in the construction industry is at risk who:

- blasts, excavates or tunnels into sandstone, clay or granite
- drills, cuts or chases into concrete and brickwork
- cuts bricks dry
- angle grinds on concrete or masonry
- jackhammers, scabbles or chisels concrete
- cleans up the dust and debris created by the above activities
- dismantles equipment covered in dust
- demolishes buildings.

Figure 7: Cutting bricks

Figure 8: Drilling into bricks

How do I manage the hazard?

Identify the hazard

Know what you are working with. Read the Safety Data Sheet (SDS) for the products that you work with and see if the ingredients listed include quartz.

If there is no SDS because the silica is generated in a tunnelling, excavating or drilling operation, you will need to seek alternative information about the likelihood of silica being present in the dust.

Management of the risk includes:

- What activities will you carry out?
- Will these activities generate dust?
- Who will be exposed?
- Do you need to control your exposures?
- How will you clean up?

Control the risk, observing the control hierarchy:

- minimise the generation of dust
- use drills and routers with dust collecting bags
- use tools fitted with a water attachment to suppress dust (on power saws, jack picks, scabbling picks.)
- fit large machinery (excavators and bulldozers) with cabs that have an effective air filtering system
- use metallic shot, slag products or grit for abrasive blasting, not sand
- wet down dusty work areas and processes
- clean up the dust with an industrial vacuum cleaner or by wet sweeping.

Important: Local exhaust ventilation or wet dust suppression has been shown to reduce dust by up to 99 per cent.

How can I protect myself?

Wear respiratory protection (see Figure 9). This generally means a P1 or P2 (particulate) or half-face filter respirator. Remember, you must be clean shaven for a respirator (dust mask) to work effectively. For abrasive blasting, an airline respirator is required.

Don’t smoke as smoking reduces the lung’s ability to clear dust and increases the risk of lung cancer.

Figure 9: Worker with P2 respirator

Case reports

The case reports below are on construction industry workers in the United States of America. More information is available at www.cdc.gov/niosh/topics/silica/

Case one

A 39-year-old man was diagnosed with silicosis (progressive massive fibrosis) and tuberculosis after working 22 years as a sandblaster. He had noticed a gradual increase in shortness of breath, wheezing, and discomfort from minimal exertion. Tissue taken from his lungs showed extensive fibrosis (scarring).

His job involved sandblasting welds during water tank construction to prepare the metal for painting. While sandblasting, he wore a filter respirator (an airline respirator would have offered better protection). During a 10 - 11hour day, he spent six hours sandblasting.

Case two

A 55-year-old man was diagnosed with simple silicosis after working 30 years as a building renovation mason. A lung biopsy revealed silicotic nodules.

Case three

A 47-year-old man was diagnosed with severe silicosis after working 22 years as a rock driller. He was diagnosed after he was brought to a hospital with respiratory failure and right heart failure and was put on a ventilator, but died. His autopsy confirmed advanced silicosis.

Before this worker's diagnosis, he had never seen a doctor and had never had a chest X-ray. The drills he used were equipped with dust controls, but they were routinely inoperable.

Need more information?

For advice on dust monitoring visit www.worksafe.qld.gov.au or call the WHS Infoline on 1300 369 915.

Visit the website to download:

- *Tunnelling Code of Practice 2007*
- *Silica – Identifying and managing crystalline silica dust exposure. Information guide. Workplace Health and Safety Queensland 2013*
- *Silica – Technical Guide to Managing exposures in workplaces. Work-related Disease Strategy 2012 – 2022. Workplace Health and Safety Queensland*

Other references

- *Public Health Guidance Note: Silica and your health. March 2002*
- *Preventing silicosis and deaths in construction workers. DHHS (NIOSH) Publication No 96-112, 1996*
- *Dust control measures in the construction industry. Annals of Occupational Hygiene, 47(3):211-218, 2003*