Environmental Crystalline Silica Exposure in Wisconsin: A Risk Assessment and Evaluation

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Abstract

As many new and proposed sand mines and processing plants in Wisconsin add to the 2,300 current industrial sources, public exposure to small and large particles including respirable crystalline silica (RCS) is increasing. RCS occupational studies have documented causation of diseases, pulmonary, kidney disease and lung cancer. Exposure to the public is regulated in five states, but not in Wisconsin where the Department of Natural Resources has determined that too few data exist to establish exposure standards. Our approach in Gaussian dispersion modeling, aerosol and gravimetric measurements, and fiber monitoring were used to assess PM 0.1, PM 0.4, PM 2.5, and RCS levels before and after construction of a large scale processing plant to assess potential health risks to a Wisconsin community. We were unable to detect RCS or PM 0.4 in the upwind area before the detection limit, which was twice the standard established in the State of California. We did measure increased aerosol (solid + liquid) concentration downwind and during plant operations. We have the need to continue monitoring to a lower detection limit in order to better determine the risks of exposure around this and other facilities.

Introduction

Particulate matter (PM) is a term used to describe a complex group of air pollutants that vary in size and composition. The PM consists of fine airborne solid particles and liquid droplets (aerosols) that vary in composition and size, including elements such as metals, nitrates, potassium, sulfate, and ammonium. Particles that are generally considered as small as 2.5 µm in diameter (PM 2.5) can be inhaled deeply into the lungs and cause respiratory effects. Silica is a semiconductor of major importance. Silica is found in a variety of forms, glasses, glass ceramics, and geologic material like crystalline silica, for example. Crystalline silica comes in a variety of forms, such as quartz, cristobalite, and tridymite, which are the most common. When respirable crystalline silica in the form of particulate matter is inhaled into the lungs, it causes irritating effects, such as silicosis, a chronic lung disease, induced by the inhalation of crystalline silica. After a short period of time, increasing lung cancer can occur. Crystalline silica is classified as a human carcinogen.

Methods

The data was collected using a DustTrak mass counter, which is sensitive to air moisture content making it difficult to determine the risk of air particle content with these measurements. The University of Wisconsin Occupational Health Laboratory (WOHL) uses a personal sampling train provided by the Wisconsin Occupational Health Laboratory (WOHL). RCS was measured using a personal sampling train provided by the Wisconsin Occupational Health Laboratory (WOHL). Three types of measurements were conducted: respirable (PM 4) crystalline silica (RCS), small (0.1-2.5 µm) and large (≥ 2.5 µm) PM aerosol count, and PM 4 aerosol mass. RCS was measured using a personal sampling train provided by the Wisconsin Occupational Health Laboratory (WOHL). Total aerosol and particle counts were measured using a Dylos laser aerosol counter (B). Grab samples of mass/volume content were measured using a Sunsrift mass counter (C).

Results

Figure 1: Average 0.5-2.5 µm Particle Concentrations

Discussion

- Total aerosol concentrations increased after the site began operations; this indicates that the site is responsible for the degradation of air quality in the area to some degree.
- Laser and HEPA filters were sensitive to air moisture content making it difficult to determine the risk of air particle content with these measurements.
- Responsible particle concentrations decreased below our detection limit, because our detection limit was twice the exposure standard. We cannot determine the risk of exposure accurately.
- Responsible silica content was below our detection limit, because our detection limit was twice the exposure standard. We cannot determine the risk of exposure accurately.
- Our measurements were one time samples and aerosol/silica content, but the generation of these particles is continuous and varies with time.
- We sampled one location but different sand facilities have different processes and procedures making exposure levels case specific per site.

Acknowledgements

- RCS was measured using a personal sampling train provided by the Wisconsin Occupational Health Laboratory (WOHL). Both dust and silica were below our detection limits. Ours detection limit for dust was 33 µg/m³ and for silica was 6.2 µg/m³. The silica was below the established standard.

References

- PM Standards | Particulate Matter | Air & Radiation | US EPA.