Effect of Deposited Polydispersed Particles on Respirable Cyclone Penetration

William A. Leach, Patrick T. O'Shaughnessy

Department of Occupational and Environmental Health, The College of Public Health, The University of Iowa

Background

Studies suggest that loading may affect particle penetration through the cyclone to the filter and therefore bias the estimate of respirable concentration. Respirable cyclones are a common instrument used to monitor occupational exposures to respirable particles and are designed to have a collection efficiency similar to the definition for the respirable fraction. However, deposited particles may influence the penetration of cyclones.

Objective

Determine if there is a difference in penetration of a clean SKC 37-mm aluminum cyclone compared to a deposited SKC 37-mm aluminum cyclone.

Methods

Glass beads (Count Median Diameter CMD 3.3 µm, Geometric Standard Deviation GSD 1.7) were used to test penetration of a clean cyclone.

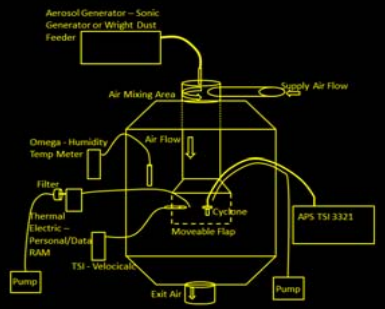
The cyclone was then sampling with one of three loading dust types for three hours at concentrations of at least three mg/m^3: Arizona Road Dust (CMD 1.04 µm, GSD 1.57), organic dust (CMD 2.90 µm, GSD 1.77), and titanium oxide (CMD 0.85 µm, GSD 1.28).

After the cyclone was deposited with dust, glass beads were used to retest the penetration.

Collection efficiencies were measured using the Aerosol Particle Sizer (APS, TSI 3321).

Mass of the cyclone and grit pot were collected at each step of the experiement.

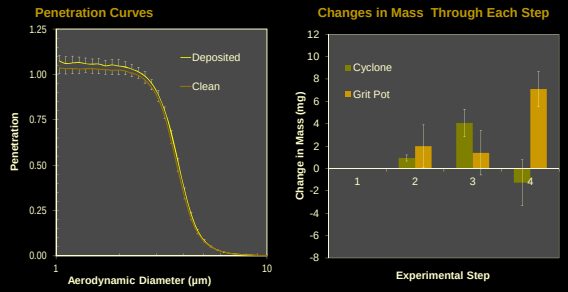
- Step 1: Clean mass before testing
- Step 2: Mass after testing clean cyclone penetration
- Step 3: Mass after 3 hours of running with loading dust
- Step 4: Mass after testing deposited cyclone penetration



Experimental Apparatus

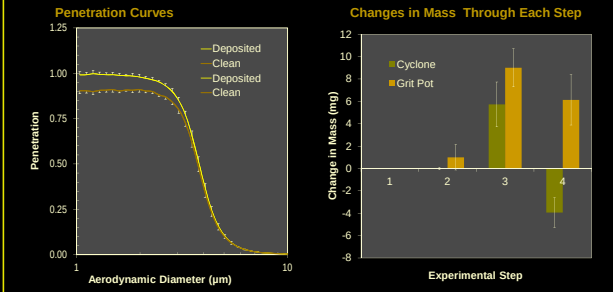
Results

Arizona Road Dust (Humidity < 50%)



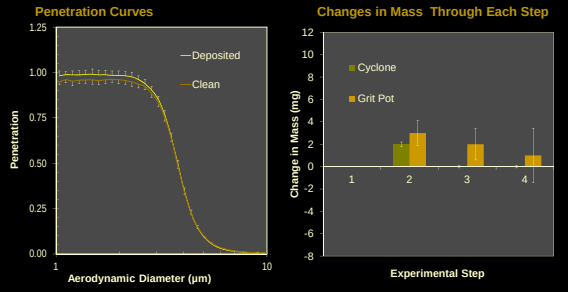
- Penetration of particles at 3.5 µm increased from 62.8 to 67.3%
- The mass of the cyclone increased an average of 4 mg from deposited particles during the loading phase

Organic Dust (Humidity < 50%)



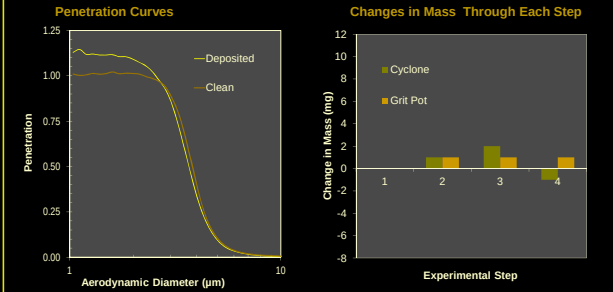
- Penetration of particles at 3.5 µm increased from 61.8 to 65.7%
- The mass of the cyclone increased an average of 6 mg from deposited particles during the loading phase

Titanium Oxide (Humidity < 50%)



- Penetration of particles at 3.5 µm increased from 63.4 to 64.2%
- The mass of the cyclone increased an average of 0 mg from deposited particles during the loading phase

Organic Dust (Humidity 95%)



- Penetration of particles at 3.5 µm decreased from 66.6 to 58.2%
- The mass of the cyclone increased an average of 2 mg from deposited particles during the loading phase

Conclusions

- Particles deposited on the walls of the cyclone caused a shift in penetration compared to clean samplers
- Sampling with deposited cyclones can cause errors by oversampling when deposited under 50% humidity, and therefore. overestimate the respirable concentration compared to a clean sampler.
- Sampling with a deposited sampler under high humidity, 95%, the penetration showed a decrease at the cut point.
- To counteract sampling errors from deposited samplers would require the cyclone to be thoroughly dried and clean before sampling.

Acknowledgements

This research was funded by CDC/NIOSH Education and Research Training Grant T42OH00849

UI COLLEGE OF PUBLIC HEALTH
DEPT OF OCCUPATIONAL & ENVIRONMENTAL HEALTH

http://www.public-health.uiowa.edu/oeh/