Evaluation of Sampling Media for Use in a Nanoparticle Respiratory Deposition Sampler

Levi W.D. Mines[1], Jae H. Park[1], Imali A. Mudunkotuwa[2], Vicki H. Grassian[2], T. Renée Anthony[1], Thomas M. Peters[1]
[1]Department of Occupational and Environmental Health, The College of Public Health, The University of Iowa
[2]Department of Chemistry, The University of Iowa

Background

- Exposure to nanoparticles is an increasing health concern
- Current exposure assessment methods for nanoparticles are expensive
- Sampling for metals may be obscured by metallic content of the sampling media
- Current Nanoparticle Respiratory Deposition (NRD) sampler uses nylon mesh containing metals

Objective

- To broaden the applicability of an innovative nanoparticle respiratory deposition (NRD) sampler by identifying alternate sampling media to collect and quantify multiple metals.

NRD sampler design

Methods

Evaluation of Sampling Media Collection Efficiency

- Sampling media were identified and classified into several groups: membranes, foams, mesh screens, and granular beds.
- Test aerosol was generated using a spark discharge system and neutralized using a ^{210}Po neutralizer.
- Two chambers were used to mix and coagulate the aerosol to achieve particle sizes from 10-300 nm.
- Fast mobility particle sizer (FMPS; 3091, TSI, US) flow was balanced to achieve 2.5 liters per minute in the sampler.
- Up and downstream concentrations were used to calculate media collection efficiency.

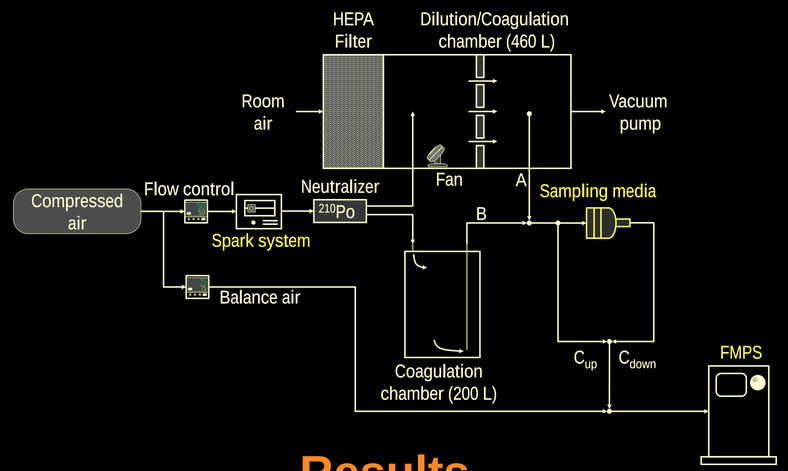
$$\eta = 1 - \frac{C_{down}}{C_{up}}$$

- Collection efficiencies were compared to the proposed nanoparticulate matter (**NPM**) sampling criterion for particles smaller than 300 nm with a 50% collection efficiency cut-point at 40 nm.

Evaluation of Sampling Media Metals Content

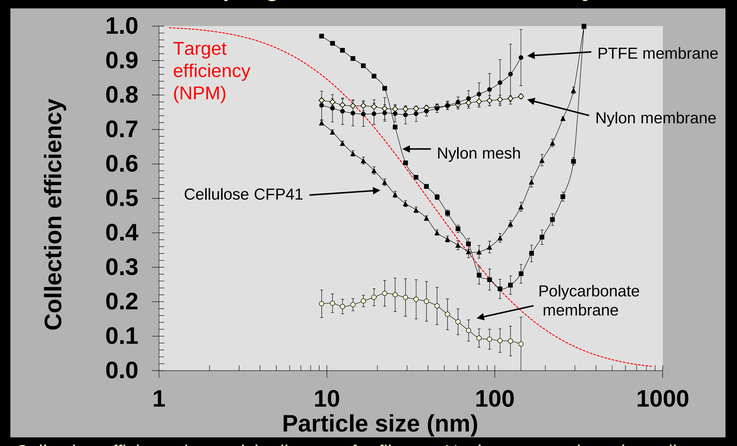
- Foam and cellulose blank media were analyzed for metals using microwave digestion followed by inductively coupled plasma optical emission spectroscopy (ICP-OES).

Experimental Setup

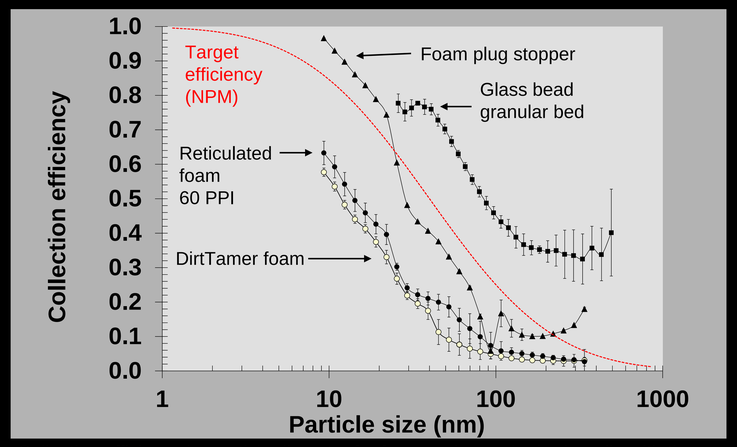


Results

Evaluation of Sampling Media Collection Efficiency

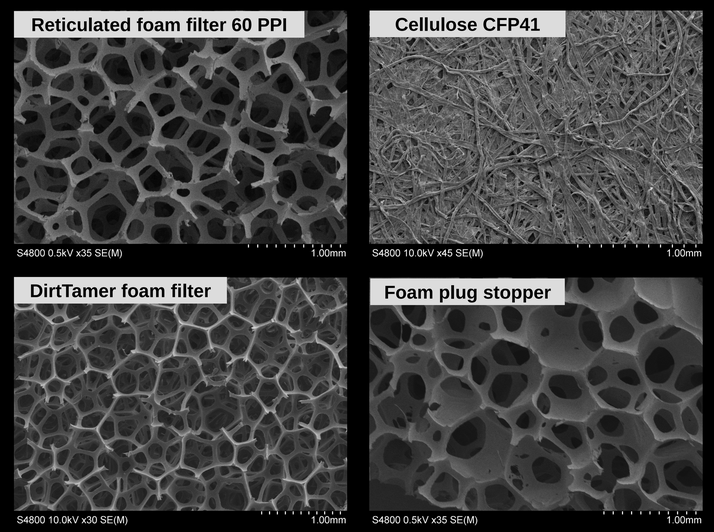


Collection efficiency by particle diameter for fibrous, Nucleopore, and mesh media with the NPM curve representing the target efficiency



Collection efficiency by particle diameter for foam and granular bed media with the NPM curve representing the target efficiency

SEM Images of Sampling Media



Evaluation of Sampling Media Metals Content

Media	Metal Content (μg/g)					
	Ti	Zn	Cu	Mn	Cr	Ni
Reticulated foam filter 60 PPI	6,10	6,10	2,0	0.1,0	0	0
Cellulose CFP41	1,1	0	1,1	0	0	0
DirtTamer foam filter	3,2	3,1	1,0	0,0	0,0	0,0
Foam plug stopper	22,6	2,2	2,0	1,0	0	0

Metal content is reported as microgram of metal per gram of sampling media from two analyses.

Conclusions

- Different sampling media (foams, mesh screens, cellulose, and granular beds) can be designed to collect particles with efficiencies matching human lung deposition for particles smaller than 300 nm.
- Low metals content of commercially available sampling media, such as cellulose and some foams, indicate that they would be appropriate for sampling and analysis of airborne metals using the NRD sampler.
- SEM imaging can be used to quantify sampling media parameters such as fiber diameter and pore size for development of a theoretical collection efficiency model.

Future Research

- Continue evaluation of sampling media at varying solidities
- Identify and evaluate new sampling media
- Evaluate pressure drop across sampling media

Acknowledgements

This research was funded by The Heartland Center for Occupational Safety and Health supported by Training Grant No. T42OH008491 and by The Centers for Disease Control and Prevention/National Institute for Occupational Safety and Health R01 grant funding.

UI COLLEGE OF PUBLIC HEALTH
DEPT OF OCCUPATIONAL & ENVIRONMENTAL HEALTH