Evaluation of a Personal Diffusion Battery

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Background

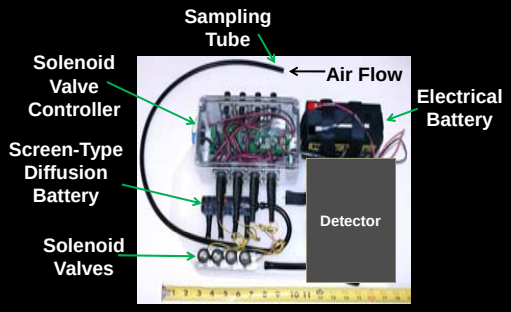
We developed a personal diffusion battery that can be placed in a backpack. When combined with a detector, it could be used to determine personal nanoparticle exposure. The personal diffusion battery was created using the theory of particle collection in a tube (Hinds, 1999) and particle collection on wire screens (Cheng, Yeh & Brinsko, 1984).

Objective

Compare personal diffusion battery to theoretical design to determine how performance differs

Design

Theoretical Screen-Type Diffusion Battery Specifications	
Housing	25 mm Conductive Cassettes
Collection Media	US Standard 635 Mesh Screens
Detector Flow Rate	1 L min^{-1}

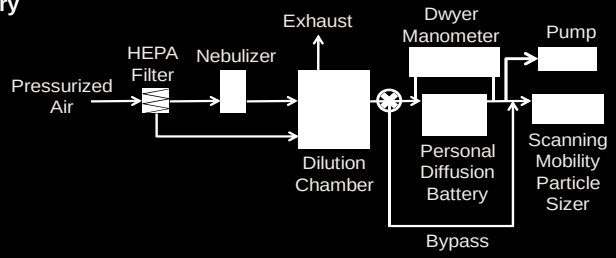


Screens Per Stage for Diameter of 50% Collection		
Stage	Number of Screens	Diameter of 50% Collection
1	No Screens	-
2	7 Screens	54 nm
3	7 Additional Screens	100 nm
4	7 Additional Screens	150 nm

Methods

Pressure drop measured with Dwyer Manometer

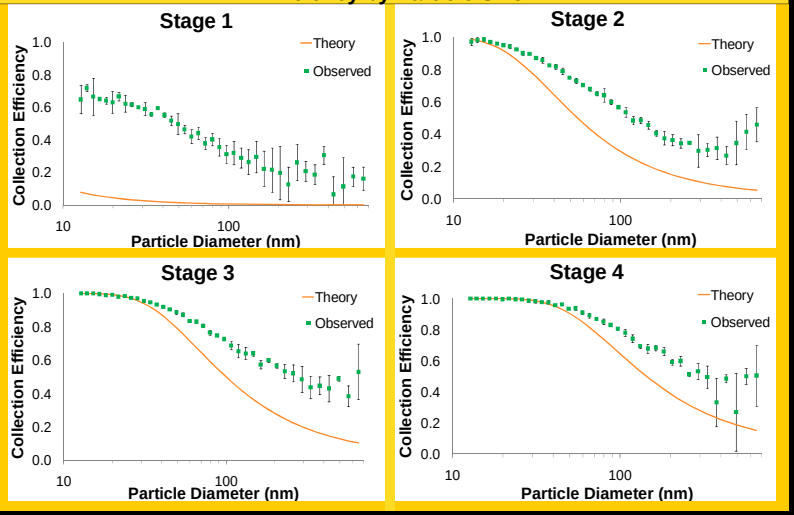
Collection efficiency determined using:
- Nebulized polydispersed ammonium fluorescein particles
- Scanning mobility particle sizer measured particle concentration by size with personal diffusion battery and bypassing the personal diffusion battery



Results

Theoretical and Observed Pressure Drop by Diffusion Battery Stage			
Stage	Theoretical Pressure Drop Across Screens (inches H_20)	Measured Pressure Drop Across Valves (inches H_20)	Measured Pressure Drop Across Screens and Valves (inches H_20)
1	-	0.63	0.75
2	0.06	0.67	0.88
3	0.11	0.62	0.87
4	0.17	0.80	0.94

Theoretical and Observed Personal Diffusion Battery Stage Collection Efficiency by Particle Size



Conclusions

- Pressure drop was greater than theorized for all four stages
- Increased pressure drop most likely due to the pressure drop across the tubing and solenoid valves, which was not accounted for in the theories
- Particle collection efficiency was greater than theorized for all four stages
- Increased collection efficiency most likely due to diffusion of particles to the tubing and solenoid valves, which was not accounted for in the theories

Future Research

- Choose detector that can overcome 1 inch H_20 imparted by diffusion battery
- Develop a data inversion using the observed collection efficiencies
- Measure personal nanoparticle exposure in various work environments

References

- Cheng, Y. S., Yeh, H. C., & Brinsko, K. J. (1985). Use of wire screens as a fan model filter. *Aerosol Science and Technology, 4*(2), 165-174.
- Hinds, W. C. (1999). *Aerosol technology* (2nd ed.) John Wiley & Sons.

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