Development of an Impinger Method to Measure Airborne Nanocellulose

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Background

- Nanocellulose is produced in three forms: nanofibers, nanocrystals (CNCs), and bacterial nanocellulose
- Cellulose nanocrystals are incorporated into products (e.g., ball-point pens) and are approaching commercialization for a variety of markets
- Limited toxicological information suggests inhalation of CNCs provokes inflammatory response
- Sampling and analysis methods are unavailable to assess airborne CNCs

Objective

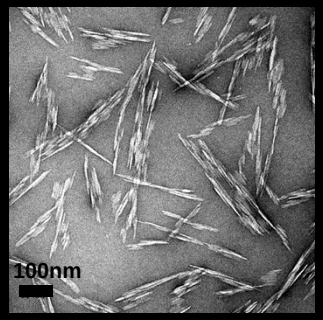
- Develop a practical sampling method to collect airborne nanoparticles apart from larger particles that may be present in the workplace
- Ensure that sampling method is compatible with sample analysis of CNCs in liquid

Methods

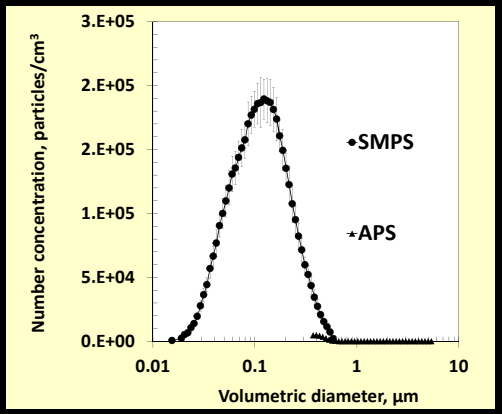
- Glass 25 mL midget impinger used for collection
- Collection efficiency measured at three flow rates and two solvent volumes
  - 1, 2, and 4 L/min
  - 10 and 20 mL deionized water
- Collection efficiency calculated from size distributions:

$$CE = 1 - \frac{C_{imp}}{C_{ref}},$$

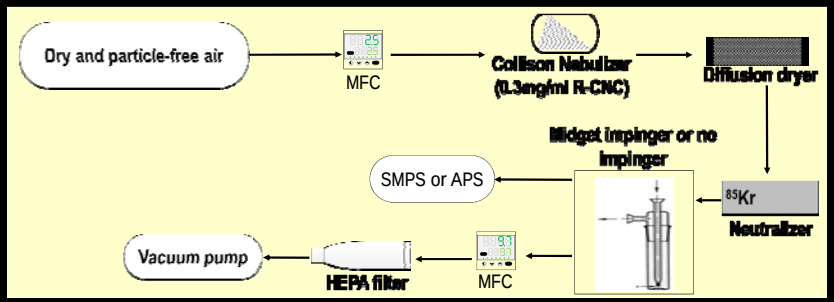
where C_{imp} is number concentration collected with the impinger and C_{ref} is number concentration collected without the impinger



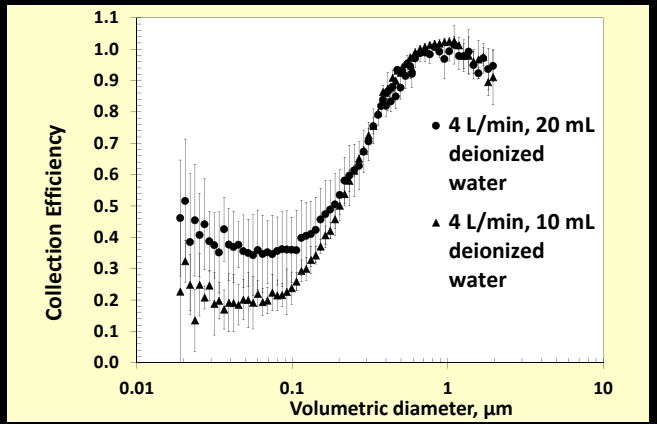
Left: TEM of CNCs deposited from solution
Right: Size distribution of CNCs after aerosolization



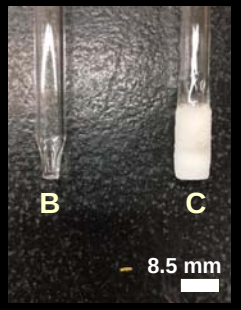
Experimental Setup



Results



- For each flowrate tested, collection efficiency with 20 mL of water was about twice that of 10 mL of water
- 4 L/min flow rate had the greatest collection efficiency (~40%) out of three flow rates tested.



Left: (A) PFA impinger, (B) standard midget impinger, (C) fritted midget impinger

Right: (B) standard impinger nozzle (d=1 mm), (C) fritted impinger nozzle (pore size= 170-220 µm)

Conclusions

- Collection of nanoparticles only can be achieved by adding an impactor prior to the impinger
- Impactor and impinger combination will allow the collection of nanoparticles directly into liquid
- CNC detection in impinger liquid confirmed by collaborators

Future Work

- Improve design by utilizing plastic (PFA) impinger with greater solvent volume
- Design impinger nozzle that mimics fritted glass to decrease bubble size and rising velocity, thus increasing particle residence time in solvent
- Design for use with Nanoparticle Respiratory Deposition sampler impactor to remove large particles for field sampling
- Evaluate design using nanoparticulate matter curve, which simulates human respiratory deposition for particles smaller than 300 nm

Acknowledgements

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