Innovative Breathing Simulation Developed to Measure Filtering Face-piece Respirators Performance

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Background

- Respirators are well-recognized personal protective equipment (PPE) used by workers to provide protection against airborne particulate.
- Respirator performance is typically tested with a one direction airflow from the outside to the inside of the mask.
- However, the pattern of human breathing consists of airflow moving in a two-way direction.
- Recent studies have been using cyclic flow to evaluate respirators performance.

Objective

- Develop an innovative breathing simulation to evaluate the particle penetration and resistance to flow of filtering face-piece respirators.

Methods

- A 0.055 m^3 chamber was constructed to evaluate the respirator.
  - The respirator was sealed to a manikin head inside the chamber.
- An Electrostatic Classifier in combination with a Condensation Particle Counter was used to measure particle size penetration.
  - A 2% Sodium Chloride aerosol was used to measure penetration through the respirator.
- A Q-track was utilized to measure Temperature and Relative Humidity inside the chamber.
- A computer program was designed with Labview Software (2010) to mimic human breathing.
  - Switching rate for the solenoid valve was every five seconds.
  - Pressure drop was measured every 30 minutes with a pressure transducer.
- A minute volume of 55 L/min was chosen to represent inhalation and exhalation under heavy work.
- Two models of N95 commercially available respirators were evaluated on particle penetration and pressure drop.
  - Respirators were from different manufacturer and were referred as Model A and Model B

Acknowledgements

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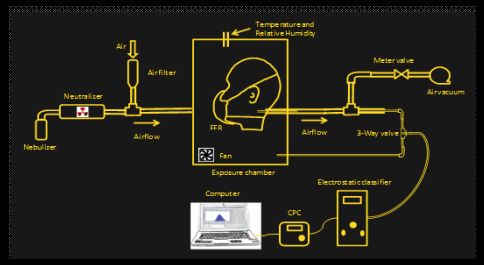
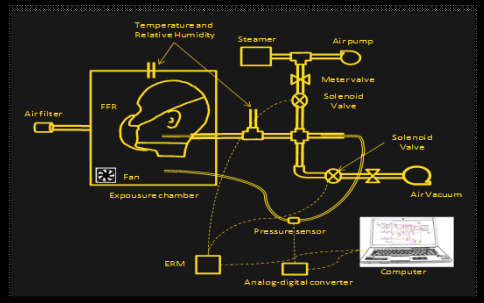
Experimental Setup



Schematic of penetration test



Schematic of resistance to flow test

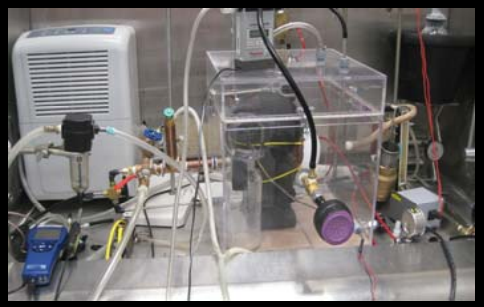
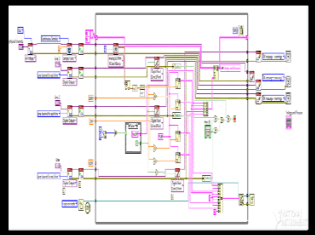
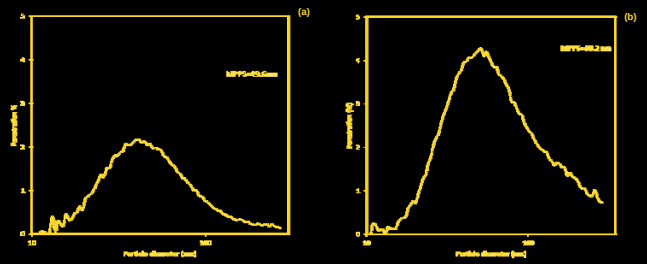


Image of equipment setup

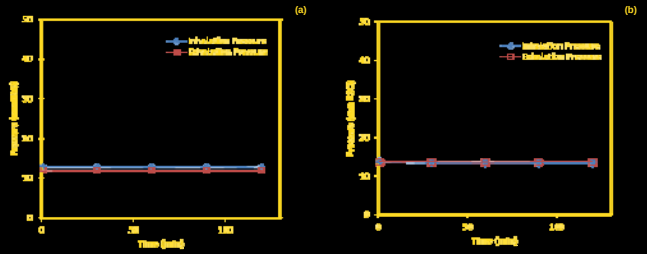


Presentation of LabView software "Block Diagram"

Results



Particle penetration for unchallenged respirator: (a) Model A, (b) Model B



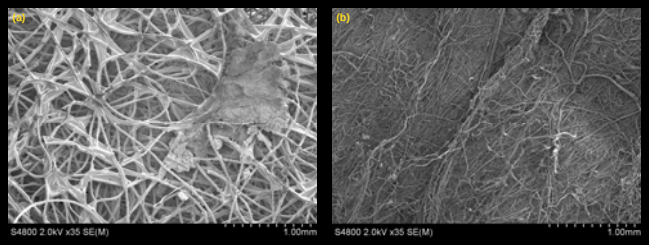
Pressure drop for unchallenged respirator: (a) Model A, (b) Model B

Conclusions

- The developed equipment set-up provides an additional system to evaluate respirators performance under cyclic flow.
- Respirators can be evaluated against different types of aerosols without using human subjects.

Future Research

- Evaluate the effects of different air conditions on resistance to flow and particle penetration of respirators.
- A Wright dust feeder will be used to add aerosol inside the chamber and challenge the respirators.



Difference in the top layer of each respirators: (a) Model A, (b) Model B.

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