BREAKTHROUGH ANALYSIS FOR FILTERING FACEPIECE MEDIA AND RESPIRATORS WITH ACTIVATED CARBON

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Background

Disposable filtering facepiece respirators (FFRs) include a wide range of products that may be certified or non-certified. Many of these respirators are being produced with activated carbon claiming nuisance level organic vapor (OV) relief.

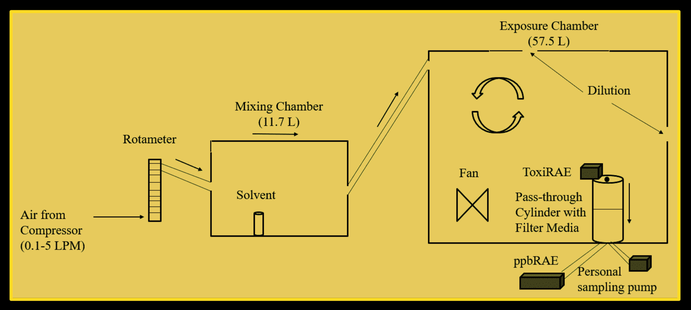
OV includes a wide range of volatile organic compounds (VOCs) which have been linked to major and minor health discomfort such as headaches, upper extremity discomfort, nausea, respiratory irritation, asthma nervous system complications, hearing loss, cancer, and death.

Objectives

1. Determine whether breakthrough times differ between two commercially available non-certified FFR-ACs (Surgical, RZ Hunting) and one certified FFR-AC (3M 8514) when exposed two VOCs;
2. Determine whether ambient humidity decreases organic vapor breakthrough time;
3. Determine if FFR-ACs can protect workers from ammonia gas;
4. Determine if human breathing through and FFR-AC influenced breakthrough time relative to results obtained with lab trials which did not include cyclic breathing. elaborated

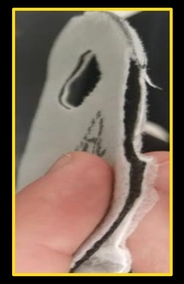
Methods

- Evaluation of filter media
  - Expose media to stable target concentrations *(15 ppm, 50 ppm, and 50 ppm with 95% RH)*
  - Measure the concentration of contaminant in the chamber (C_{in}) and after filter media (C_{out})
  - Determine breakthrough as $B = C_{out}/C_{in}$

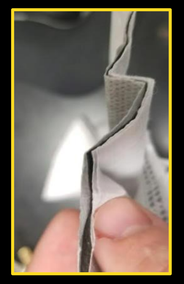


Media and Performance

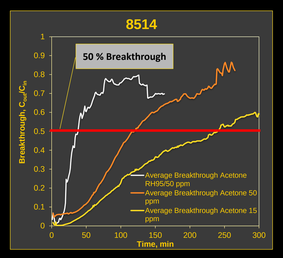
3M 8514



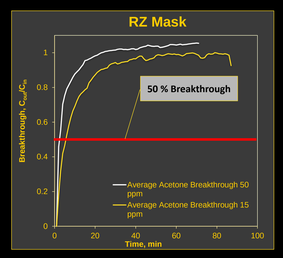
RZ Mask



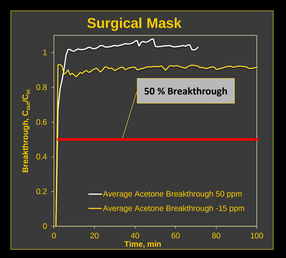
Surgical Mask



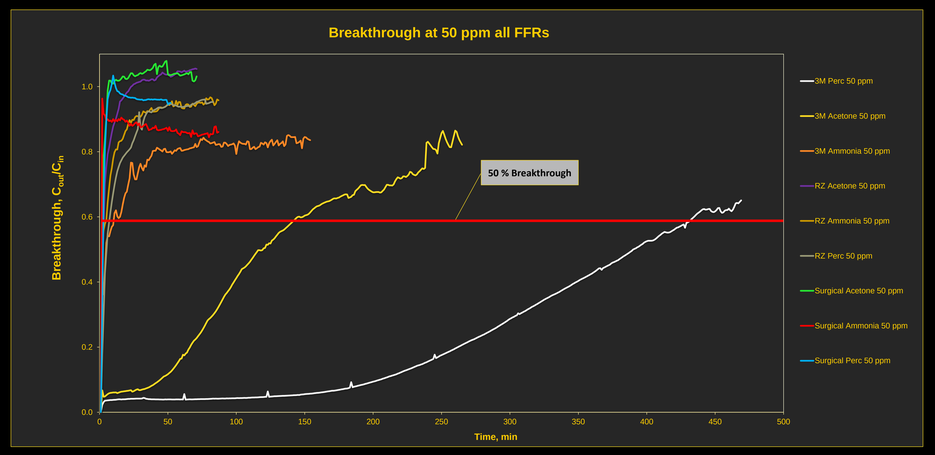
Breakthrough curves for 8514 across humidity and acetone concentration. Ambient humidity for 50 ppm and 15 ppm trials was an average of 48%.



Breakthrough curves for RZ Mask for acetone concentration. Ambient humidity for 50 ppm and 15 ppm trials was an average of 48%.



Breakthrough curves for Surgical Mask for acetone concentration. Ambient humidity for 50 ppm and 15 ppm trials was an average of 48%.



Breakthrough curves for all FFRs at 50 ppm when exposed to acetone, perchloroethylene, and ammonia. Ambient humidity for 50 ppm trials was an average of 48%.

Results

The non-certified respirators, (RZ Hunting Mask and Surgical Mask), were ineffective for all vapors and offered less than 10 minutes of protection before 50% breakthrough occurred.

Respirators performed poorly, when exposed to ammonia, with breakthrough less than 5 mins at 50 ppm and 10 minutes at 15 ppm.

The 8514 respirator had the longest breakthrough times for all trials. Acetone 50% breakthrough occurred at 121 minutes for 50 ppm and 233 minutes at 15 ppm. Perchloroethylene took over 400 minutes to achieve 50% breakthrough at 50 ppm. When acetone at 50 ppm and perchloroethylene at 50 ppm were evaluated with 95% R.H., breakthrough times decreased to 39 and 144 minutes respectively, a nearly 70% decrease in time for both vapors.

Conclusions

- The non-certified FFR-ACs both had much faster breakthrough times than the 3M 8514 respirator.
- Breakthrough times are dependent on concentration, humidity, and molecular characteristics of the vapor.
- Breakthrough curves were shifted left with higher ambient humidity, when all other conditions were held fixed.
- None of the respirators could provide extended protection from ammonia vapors.

Acknowledgements

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