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Technical Bulletin

February 2024

Respiratory Protection for Ozone

Summary

This technical data bulletin describes testing of 3M reusable respirator and powered air purifying respirator (PAPR) filters and cartridges against ozone along with 3M recommendations for use. In addition, 3M disposable respirator ozone testing and performance is described, along with 3M recommendations for use. This data may be used to help determine a change schedule for respirator filters and cartridges and disposable respirators used against ozone.

Background

According to the US National Institute for Occupational Safety and Health (NIOSH), ozone "is used for purifying air and drinking water, in industrial waste treatment, oils, bleaching and waxes, and to make other chemicals." It is also present in welding applications. It can cause irritation to the eyes, nose, and throat, and at higher concentrations can lead to headache, upset stomach, shortness of breath and lung damage[1] .

However, NIOSH does not have a respirator test method or approval for ozone. Previous research has shown the ability of a disposable particulate respirator with a thin layer of carbon to filter 1 ppm ozone for up to 8 hours at flowrates of 64 liters/min[2] . Although ozone is an oxidizer, Johnston et al., did not find any oxidation effects during their tests.

Ozone Test Method: Cartridges and Filters

Occupational exposure limits (OELs) for ozone vary by country or region. The US OSHA 8-hour time weighted average limit for ozone and the NIOSH ceiling limit is 0.1 ppm. Therefore, service life testing was done at approximately 1 ppm ozone (10 times the OEL). Pure oxygen was passed through a mass flow controller (Brooks Model GC-100CXXC) to an ozone generator (Oxidation Technologies HTU-500). This was mixed with humidified air and then passed through the respirator cartridge/filter. The sample stream was plumbed using fluorinated ethylene propylene tubing to ensure the ozone did not react with the tube surface. Reusable respirator cartridges and filters were tested at approximately 64 L/min which is the test flow used by NIOSH for gas/vapor cartridges. This flow rate also corresponds to breathing during heavy work[3] . PAPR cartridges were tested at flow rates similar to the PAPRs in use. Humidity was controlled to approximately 30%, 50% or 70% RH using a 3M propriety controller. A limited amount of testing was also done at 85% RH to investigate the effect of high relative humidity. Both the cartridge challenge and exit concentration were monitored with ozone detectors (2B Technologies 106-L) which have a 3 part per billion (ppb) limit of detection and accuracy of 1.5 ppb or 2% of the reading, whichever is greater.

1. "Ozone" NIOSH CDC https://www.cdc.gov/niosh/topics/ozone/ accessed Feb 1, 2024
2. "Ozone Removal Capability of a Welding Fume Respirator Containing Activated Charcoal." A.R. Johnston, J.F Dyrud and Y.T. Shih. American Industrial Hygiene Association Journal, 50:451-454 (1989)
3. "Respirator Cartridge Efficiency Studies VIII. Summary and Conclusions." G.O. Nelson and A.N Correia. American Industrial Hygiene Association Journal, 36:514-525 (1976)

Results and Recommendations

The following 3M products are 3M recommended for use against up to 1 ppm ozone with an estimated service life of up to 40 hours. These products are not NIOSH approved for use against ozone. If using these filters or cartridges for ozone and additional gas/vapor/particulate hazards, consult appropriate product*User Instructions*for additional guidance on time use limitations.

- 3M™ Adflo™ Organic Vapor/Acid Gas Cartridges, 15-0499-99
- 3M™ Versaflo™ Organic Vapor/HEPA Cartridge TR-6510N
- 3M™ Particulate Filter 2078, P95, with Nuisance Level Organic Vapor/Acid Gas Relief
- 3M™ Secure Click™ Particulate Filter P95 with Nuisance Level Organic Vapor/Acid Gas Relief, D3078
- 3M™ Half Facepiece Disposable Respirator Assembly 5101, Organic Vapor, Small
- 3M™ Half Facepiece Disposable Respirator Assembly 5201, Organic Vapor, Medium
- 3M™ Half Facepiece Disposable Respirator Assembly 5301, Organic Vapor, Large
- 3M™ Organic Vapor Cartridge 6001
- 3M™ Organic Vapor Cartridge/Filter 60921, P100
- 3M™ Secure Click™ Organic Vapor Cartridge D8001
- 3M™ Secure Click™ Organic Vapor Cartridge/Filter P100 D80921, with Dual Flow

The following 3M products are 3M recommended for use against up to 1 ppm ozone with an estimated service life of up to 8 hours. These products are not NIOSH approved for use against ozone. Consult product*User Instructions*for additional time use limitations.

- 3M™ Particulate Filter 2097, P100, with Nuisance Level Organic Vapor Relief
- 3M™ Advanced Particulate Filter 2297, P100, with Nuisance Level Organic Vapor Relief
- 3M™ Secure Click™ Particulate Filter P100 with Nuisance Level Organic Vapor Relief D3097

The following cartridges or filters are **not recommended** for hazardous levels of ozone, but may instead be used for nuisance odor relief:

- 3M™ Hydrogen Fluoride Cartridge/Filter 7093C, P100, with Nuisance Level Organic Vapor and Acid Gas Relief
- 3M™ Secure Click™ Hard Case P100 Particulate Filter D9093C, Hydrogen Fluoride and Nuisance Level Organic Vapor and Acid Gas Relief

To investigate any potential oxidation effects, cartridges and filters were tested at approximately 10 ppm at 70% RH for 4 hours. No noticeable increase in temperature was observed in the air stream nor any physical markings on the outside of the cartridge or filter due to the removal of ozone.

Conclusion

NIOSH does not have a respirator test method or approval for ozone. Based on internal testing, 3M RR and PAPR organic vapor cartridges or organic vapor/acid gas cartridges (as stated above) may be used to filter ozone up to 1 ppm for up to 40 hours. 3M RR and PAPR particle filters with a thin layer of carbon for “nuisance organic vapors” had variable performance and must be considered individually. No noticeable oxidation reaction (e.g. increased temperature) was noticed as a result of filtering 10 ppm ozone. 3M Disposable Respirators, 8214 and 8514, are recommended for ozone protection up to 10X PEL/OEL, for up to 8 hours. Until further study is done, supplied air respirators are suggested for ozone concentrations > 1 ppm.

Personal Safety Division
3M Center, Building 235-2W-70
St. Paul, MN 55144-1000

3M PSD products are occupational use only.

3M Canada
P.O. Box 5757
London, Ontario
N6A 4T1

In United States of America
Technical Service 1-800-243-4630
Customer Service 1-800-328-1667
3M.com/workersafety

In Canada
Technical Service 1-800-267-4414
Customer Service 1-800-364-3577
3M.ca/Safety