

Respiratory Protection for Hydrogen Peroxide, Peracetic Acid and Acetic Acid

Background

Peracetic acid may be used as a broad spectrum biocide or drug neutralizing agent in medical, food processing and industrial applications. It is a powerful oxidizing agent that kills microorganisms by penetrating the cell wall. It is even effective against anthrax spores.

Peracetic acid is produced by reacting acetic acid and hydrogen peroxide. This creates an equilibrium mixture of acetic acid, hydrogen peroxide and peracetic acid. The vapor above a peracetic acid solution contains all three of these compounds. Thus, a cartridge for use against peracetic acid must be capable of removing all three compounds.

Both acetic acid and peracetic acid vapors are “organic vapors” and thus may be filtered by 3M organic vapor, organic vapor/acid gas or multigas cartridges, or European cartridges with a type “A” approval. Cartridge effectiveness against hydrogen peroxide (H_2O_2) vapor, however, has been less clear. In the past 3M has recommended supplied air respirators for hydrogen peroxide; however, recent laboratory studies support a change in this recommendation.

Negative Pressure Cartridge Testing

3M 6003 Organic Vapor/Acid Gas and 6006 Multi-Gas/Vapor cartridges were tested for 8 hours against hydrogen peroxide vapor concentrations up to ~ 90 ppm with a relative humidity of 50% and flow rate of 30 L/min through the cartridge. Because each respirator uses two cartridges, this is equivalent to 60 L/min airflow (30 Lpm x 2 cartridges), which is considered a heavy work rate. No breakthrough was detected.

Solvay Chemicals, Inc. had respirator cartridges from various manufacturers tested including 3M organic vapor, organic vapor/acid gas and European ABEK2P3 cartridges (model numbers not specified). At concentrations of 100 ppm hydrogen peroxide, 150 ppm peracetic acid, and acetic acid (concentration not specified), flow rate of 32 L/min and up to 80% relative humidity, cartridges were effective for at least 8 hours. The “Hydrogen Peroxide/PAA Respirator Cartridge Service Life Technical Data Sheet” is available at www.solvaychemicals.us and search for “Respirator Peracetic Acid.”

Powered Air Purifying Respirator (PAPR) Cartridge Testing

The following 3M PAPR cartridges were tested against mixtures of acetic acid, hydrogen peroxide, and peracetic acid in a series of experiments:

- TR-6510N Organic Vapor/HEPA
- TR-6530N Organic Vapor/Acid Gas/HEPA
- TR-6110E A1P
- TR-6310E A2P
- TR-6130E ABE1P
- TR-6580E ABEK2HgP
- Jupiter A2P
- Jupiter ABE1P

Cartridges were tested against a mixture of ~ 210 ppm acetic acid, 130 ppm hydrogen peroxide, 80 ppm peracetic acid at a flow rate of 170 L/min, and ~ 50% relative humidity. Service life was at least 8 hours with acetic acid breaking through first.

A subset of these cartridges were tested against lower exposure mixtures: ~ 30 ppm acetic acid, 14 ppm hydrogen peroxide and 5 ppm peracetic acid, 170 L/min and ~ 50 to 80% relative humidity. Cartridges were tested against either continuous exposure or cycles of intermittent exposure followed by 8 to 16 hours storage. Acetic acid broke through before hydrogen peroxide or peracetic acid in all cases. Service life was 70 to 120 hours until either 1 ppm acetic acid breakthrough or the test was stopped. No obvious difference was seen between cartridge type, 50% RH and 80% RH, or continuous and intermittent exposure testing.

Discussion

Based on the above test results, 3M cartridges which include either a NIOSH “organic vapor” or European type “A” approval are able to filter acetic acid, hydrogen peroxide and peracetic acid mixtures. If there are mists or other aerosols present, a particulate filter must be added (if not already included in the cartridge). All of the PAPR cartridges tested have a particle filter included.

Based on the higher concentration testing, PAPR cartridges seemed to have service life similar to the smaller negative pressure cartridges. This may be because even though PAPR cartridges typically have more carbon, they operate at a higher flow rate. Negative pressure cartridges were not tested at the lower exposure concentrations, but would be expected to have service life similar to the PAPR cartridges.

The test concentrations in these experiments are higher than what may be expected or allowed for respirator use. The maximum use concentration for respirators is whichever is lower between:

- 1) (occupational exposure limit) x (respirator protection factor), or
- 2) exposure concentration that is considered immediately dangerous to life or health (IDLH).

In many countries, the exposure limits for these chemicals are in the range of 0.4 to 10 ppm. The lower exposure concentration testing was about 2 to 10 times higher than these exposure limits. Cartridge service life will be longer if used against lower exposure levels and shorter if used against higher exposure levels.

PAPR cartridges were tested at 170 L/min to mimic NIOSH criteria. Nominal PAPR flow rates for the TR-600/800 and Jupiter PAPRs are approximately 205 and 190 L/min respectively. Therefore cartridge service life may be slightly shorter when used with these PAPRs.

Cartridges that were intermittently exposed and stored did not last noticeably longer than cartridges that were continuously exposed. This is possibly due to migration of acetic acid through the cartridge during storage, which is a known phenomenon for organic vapors. Thus, service life estimates for organic vapor cartridges are most conservatively seen as time from first use (running clock). For example, if the estimated cartridge service life is 96 hours, this is most conservatively viewed as 4 consecutive days, not separate hours spread out over a much longer time period.

Use Limitations

Acetic Acid, hydrogen peroxide and peracetic acid are all potent eye irritants. Either a PAPR with appropriate headgear, a full facepiece respirator or a half facepiece respirator with suitable eye protection should be worn.

Cartridges and filters should not be allowed to come into direct contact with concentrated solutions of peracetic acid or hydrogen peroxide.

Respirator cartridges and filters should not be used for scrubbing peracetic acid or hydrogen peroxide from the exhaust of sterilizers or decontamination units. The very high vapor concentrations from scrubbing exhaust could potentially cause ignition of the carbon sorbent if peroxides accumulate on the carbon bed.

WARNING

Disclaimers

All statements, technical information and recommendations are based on a general assessment of current regulations and industry practices as referenced herein as of the date of this document. Users must ensure suitability for their intended use of PPE based on workplace risk assessment, law and regulations. Unless prohibited by applicable law, 3M disclaims all responsibility for any errors, omissions or reliance on this information.

Respirators help reduce exposures to certain airborne contaminants. Before use, the wearer must read and understand the User Instructions provided as a part of the product packaging. Misuse may result in sickness or death. For correct user, consult supervisor and User Instructions, or call 3M PSD Technical Service.