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Technical Bulletin

July 23, 2019

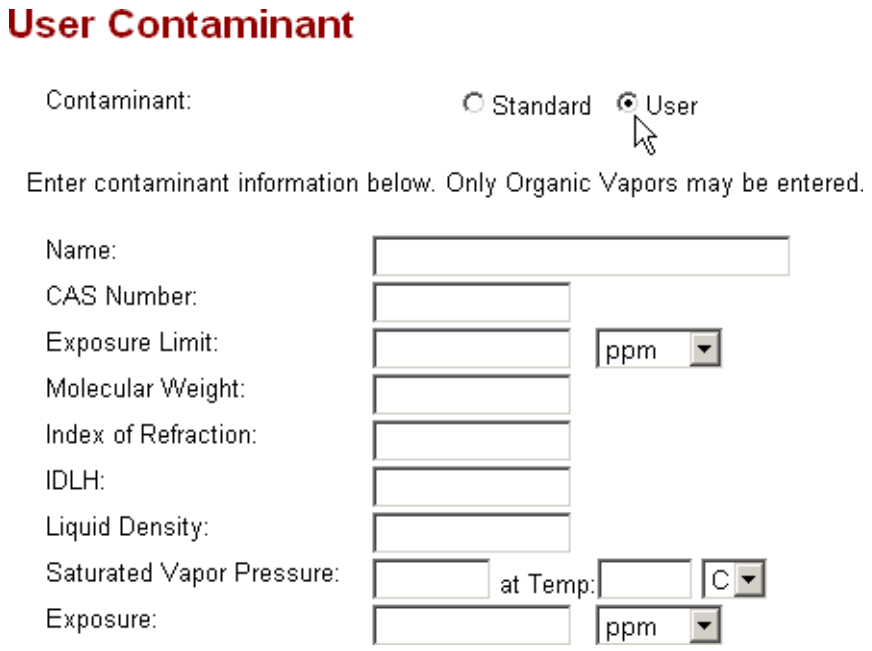
Establishing Cartridge Change Schedules for Anesthetic Gases (Isoflurane, Sevoflurane)

Background

Minimizing exposure to anesthetic gases is best done by proper administration technique and local exhaust ventilation (scavenger systems). Respirators may also be used to help further reduce exposure. Respirators with organic vapor cartridges may be used during exposure to anesthetic gases such as isoflurane and sevoflurane. However, gas and vapor cartridges have a limited service life. The United States Occupational Safety and Health Administration (OSHA) standard for respiratory protection (29 CFR 1910.134) mandates that users develop cartridge change schedules based on either "end of service life indicators" or empirical data.

Estimating Cartridge Service Life

Many respirator manufactures have developed software programs to help users develop cartridge change schedules. The 3M™ Service Life Software may be found at www.3M.com/sls. The software includes many common industrial chemicals. Users may also enter their own "user defined" organic vapors. The user must supply information about the organic vapor as shown in the form below.



CAS number and the Immediately Dangerous to Life or Health (IDLH) level are only for reference and are not required to estimate service life. The exposure limit is only used if the user chooses to estimate service life until the amount of vapor coming through the cartridge is equal to some fraction of the exposure limit. If the user instead chooses to estimate service life until the amount of vapor coming through the cartridge is a fraction of the ambient concentration, then the choice of exposure limit is not relevant. Since many of the anesthetic gases do not have published exposure limits, the user will need to enter an arbitrary number of choice (e.g. 100 ppm) and then select breakthrough to a fraction of the ambient concentration. In order to use the software, exposure must be measured for the user's specific application. 3M™ Organic Vapor Monitors may be used to measure certain anesthetic gases.

The remaining chemical information is given in the table below. Saturation vapor pressure depends on temperature. The Service Life Software program allows temperatures selected in 10 °C increments, so saturation vapor pressure is given at both 20 °C and 30 °C. Organic vapor cartridge service life decreases with increasing temperature, so calculations done at 30 °C will give a conservative estimate for temperatures between 20 °C and 30 °C.

Name	Isoflurane	Sevoflurane
CAS Number	26675-46-7	28523-86-6
Molecular Weight	184.5	200.1
Index of Refraction	1.3002	1.2752
Liquid Density	1.496	1.52
Saturated Vapor Pressure	238 mm @ 20 °C 367 mm @ 30 °C	157 mm @ 20 °C 244 mm @ 30 °C

The service life software estimates how long a cartridge will last if it is exposed continuously (e.g. 40 hours). However, many users ask about intermittent use for shorter periods of time. This is a more difficult question as organic vapors may migrate through the cartridge during periods of non-use. This is especially a concern for organic vapors with a boiling point less than 65 °C, which includes many anesthetic gases. One conservative approach would be to use the estimate from the software as the time since the cartridges were first exposed. Thus, cartridges are disposed when the time (use and non-use together) has expired. (See 3M Technical Bulletin #142, "Reuse of Organic Vapor Chemical Cartridges" for more information).

3M has also tested the 3M™ Organic Vapor Cartridges, 6001 against intermittent exposure of isoflurane. Two 6001 cartridges were each challenged with 10 ppm isoflurane in air at 32 liters/minute and 50% RH for 30 minutes every day for 6 days. (Flow rate of 32 liters/minute through each cartridge of a dual cartridge respirator is equivalent to 64 liter/minute flow through the respirator which is a moderate to heavy breathing rate). One 6001 cartridge was challenged with 50 ppm isoflurane under the same conditions. During these 30 minute periods the effluent air from the cartridges was analyzed for isoflurane by gas chromatography. No isoflurane was observed in the effluent (0.1 ppm detection limit) at any time during the 6 days.

The test data show that 6001 cartridges may be used up to 6 days of intermittent isoflurane exposure if use conditions are similar to our testing. However, cartridges should be stored in a cool dry place between periods of use. Service life may be shorter if used at higher concentrations, high relative humidity or if other organic vapors are also present. Sevoflurane is less volatile than isoflurane and thus service life under the same conditions would be longer.

It should be noted that respirators help reduce, but do not eliminate exposure. Respirators must be used as part of a comprehensive respiratory protection program that includes, but is not limited to training, fit testing, medical evaluation, inspection, maintenance, etc. In the United States, employers providing respiratory protection must follow the OSHA Respiratory Protection Standard 1910.134.

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

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