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Technical Data Bulletin

#244 - Cartridge Change Schedules for Low Exposure Environments

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Introduction

In many countries, respirator cartridges must be replaced according to either an end of service life indicator (ESLI), or a change schedule based on objective data. Objective data often means monitoring worker exposure levels and then entering the results into software programs to estimate cartridge service life. However, sometimes the data is entered without first considering if the exposure levels are less than occupational exposure limits (OELs). This step could help determine whether or not a cartridge change schedule is necessary, and what change schedule options might be appropriate.

Hazard Assessment

The first step in selecting respirators or determining cartridge change schedules is to identify the contaminants present. Personal air monitoring should be taken near the worker's breathing zone for a representative number of workers, activities, and environmental conditions in order to assess worker exposure. For example, 3M Diffusion Monitors may be used to sample certain organic vapors, formaldehyde or ethylene oxide. Data is then analyzed considering possible variability in worker exposure.

A hazard ratio may be calculated as the exposure level divided by the OEL. For mixtures, the simplest approach is to sum the hazard ratios (or the hazard ratios for those chemicals that affect the same organs in the body). For example, 3/25 + 1/20 + 12/100, etc. If the summed hazard ratio is less than one, a respirator may not be required. If the hazard ratio is greater than one, exposures must be reduced using engineering controls, administrative controls, or respirators.

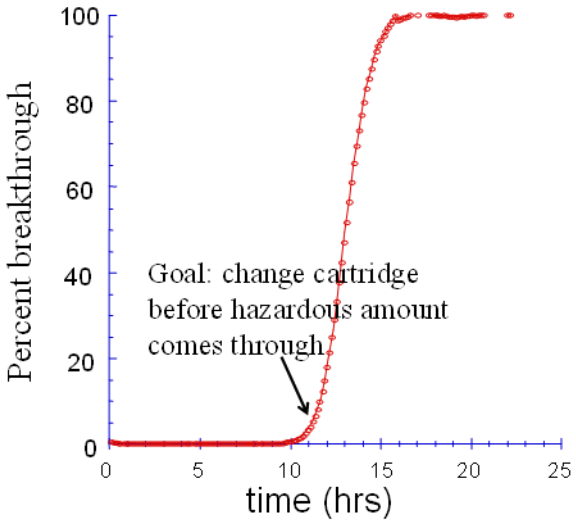
Regulatory Considerations

Regulatory requirements for developing cartridge change schedules vary by location. Some countries allow contaminant odor, taste or irritation to be used as an indication of when to change cartridges. However, some gases and vapors have poor warning properties, and some people do not have a good sense of smell. Therefore, relying on contaminant warning properties is not recommended.

Countries such as the U.S., Canada and Australia require an ESLI or cartridge change schedules. However, US OSHA has separate requirements based on whether or not respirators are used voluntarily by employees. If gas/vapor respirators are required by the employer (regardless of the exposure levels) then a change schedule must be implemented—29 CFR 1910.134(d)(3)(iii). In contrast, if respirator use is voluntary, then cartridge change schedules are not required—29 CFR 1910.134(c)(2).

Gas/Vapor Cartridge Service Life

A typical gas/vapor breakthrough curve is shown below. If the proper cartridge has been selected for the application, there will be no significant gases or vapors exiting the cartridge for a period of time. Then, as breakthrough commences, the amount coming through the cartridge will increase sharply. The goal is to change the cartridge before a hazardous amount exits the cartridge.



However, if the exposure outside the respirator is low enough to be considered non-hazardous, then the amount eventually coming through the cartridge will also be non-hazardous. Therefore, choice of when to change the cartridge is somewhat arbitrary. From a practical perspective,

choose a change schedule that is easy for workers to remember (e.g. 1 week, 1 month, etc.). Change cartridges earlier if contaminant odor, taste, or irritation is detected inside the facepiece.

A variant of the above scenario is a mixture with some of the gases or vapors at hazardous levels, and some below hazardous levels. For determining cartridge change schedules, we are concerned with the gases and vapors with the shortest cartridge service life. For organic vapors, these are the chemicals with the highest vapor pressure (e.g. acetone, isopropanol, etc.). If the contaminant with shortest service life has exposure levels below hazardous levels (even after considering possible health effects from mixtures), it may be removed from the service life consideration.

For example, a painter is exposed to a mixture of organic vapors including very low levels of acetone. Exposure information for all of the gases and vapors are entered into a service life software program. The estimated service life is very short based on acetone going quickly through the cartridge. Realizing that the amount of acetone coming through the cartridge is well below hazardous levels, acetone is removed from the service life software, and the estimate is run again.

Conclusion

The 3M™ Service Life Software (www.3M.com/ServiceLifeSoftware) can be a powerful tool to estimate service life for many different contaminants and 3M respirator cartridges. However, first consider whether or not respirators and/or a cartridge change schedule is required. For respirators used voluntarily in non-hazardous environments, a cartridge change schedule may not be required depending on local regulations. If respirators are required in a non-hazardous environment, then a change schedule is required, but it could simply be a schedule that is easy for workers to remember (e.g. 1 week, 2 weeks, etc.) If cartridge service life is short due to a certain a gas or vapor, but that gas/vapor is well below exposure limits, it may be removed from the service life calculation.

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