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Technical Data Bulletin

#245 - Overview of Exposure Monitoring for Respiratory Hazards

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Introduction

It is the employer's responsibility to both evaluate and control workplace hazards, not only for worker health and safety, but also to comply with local regulations. This technical bulletin is a brief overview of monitoring worker exposure to respiratory hazards. Exposure monitoring results may then be used to help select respiratory protection and determine cartridge service life.

Exposure Monitoring

Potential respiratory hazards may be identified by first examining the manufacturing process and raw materials used. Safety data sheets list material composition by percent, but this is not the same as measuring airborne exposure levels. Air monitoring may be done either for an area, at the contaminant source, or for individual workers.

Area monitoring is carried out to measure the concentration level in a given area. This can be useful to detect seasonal variation or process cycles and to evaluate engineering controls. However, this method cannot be used to measure personal exposure as workers may move closer to or further away from the contaminant source during their work.

Source monitoring is done at the source of the contaminant. It may be used to evaluate the need for, or performance of, ventilation systems at the source of the contaminant. It may also be used to monitor potential 'worst case' personal exposure.

Personal sampling is the only way to measure actual worker exposure. Usually the sampler is clipped near the front of the worker's shirt collar in order to measure contaminant levels in the worker's breathing zone.

Choice of sampling method is determined by the nature of the contaminant and the desired sampling time. Direct reading "real time" methods (e.g. electronic or colorimetric indicators) give immediate results. They are required for environments with potentially explosive atmospheres, lack of oxygen, or chemicals with immediate adverse health effects. In contrast, sampling methods that include laboratory analysis may be used where immediate results are not needed.

Different sampling methods are available for particles, gases and vapors. Some methods are designed in order to give results that can be compared to the relevant exposure limits (e.g. respirable sized particles, inhalable fraction and vapor, etc.). For a list of industrial hygiene sampling methods from OSHA and NIOSH please see the following links:
http://go.3M.com/OSHASamplingMethods
http://go.3M.com/NIOSHAnalyticalMethods

Workers should be characterized into similar exposure groups (SEG) based on tasks and/or exposure time, with a representative number of samples taken from each SEG. An explanation should be given to the workers as to why the sampling is being performed and any instructions that need to be followed.

It may be necessary to sample for different durations. For example, one set of samples may be used to compare against 8 hour time weighted average (TWA) exposure limits. However, if there are intermittent spikes in exposure, another set of samples may be needed to compare against 15 minute short term exposure limits (STEL) or ceiling limits.

Blank samples should also be collected by opening the sampling device in a clean environment and immediately closing it, similar to handling a real sample. Blank samples are used to check for contaminants from the sampling device itself, handling and shipping, or the analysis process.

Sampling should be repeated periodically, if there is a change to the manufacturing process or workplace environment, an employee complaint or illness, or sooner according to applicable regulations.

3M Diffusion Monitors

3M Organic Vapor Monitors (3500, 3510, 3520, 3530) may be used to sample many organic (solvent) vapors such as benzene, toluene, xylene, etc. Also available are 3M Formaldehyde Monitors (3720, 3721) and 3M Ethylene Oxide Monitors (3550, 3551). 3M monitors are small, lightweight and easy to use (no pump to charge or calibrate). They are accurate to with +/-25% for many contaminants, exposure levels and sampling times. However, they are not for sampling particles or certain gases or vapors.

3M monitors may be purchased with or without pre-paid analysis. Monitors with prepaid analysis includes detailed instructions for submitting the samples for evaluation. Monitors without pre-paid analysis should be sent to an American Industrial Hygiene Association (AIHA) accredited lab that is familiar with the chosen sampling method. For a list of accredited labs, please visit:
www.aihaaccreditedlabs.org/AccreditedLabs/Pages/default.aspx

For more information about 3M monitors, visit www.3M.com/WorkerSafety or see additional technical data bulletins such as the 3M Organic Vapor Monitor Sampling and Analysis Guide: http://go.3M.com/OVMSampleGuide

Interpreting Monitoring Results

There will naturally be variability in monitoring results. An industrial hygienist may be needed to interpret the data as the numbers plus some measurement of the variability. Excessive variability may be a result of issues such as uncontrolled exposure, mischaracterization of the SEG, or the need for additional samples.

Monitoring results may be compared to occupational exposure limits (OEL) such as the OSHA Permissible Exposure Limit (PEL) or ACGIH Threshold Limit Value® (TLV®). OELs for many common industrial contaminants may be found in the 3M Respirator Selection Guide:
http://go.3M.com/SelectionGuide

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 hazard ratio is greater than one, exposures must be reduced by substituting a safer material, providing better engineering controls such as local exhaust ventilation, or limiting the employees' duration of exposure. Until these changes are made, or if they are not adequate, respirators may be used to help reduce the employees' exposure to below the exposure limits.

Respirator Selection and Cartridge Change Schedules

If respirators are used, they must be able to reduce exposure to below the OEL. When properly selected, fitted, used and maintained, respirators are expected to reduce exposure by their protection factor. OSHA lists assigned protection factors (APF) in their respirator standard: 29 CFR 1910.134. For example, half mask respirators have an APF of 10, meaning they can reduce exposure by a factor of 10 (or 90%). Full facepieces, powered or supplied air respirators are necessary if the hazard ratio is > 10. For more information, please see the OSHA respirator standard or the 3M Respirator Selection Guide.

In the US and certain other countries, gas/vapor cartridges must be replaced according to an end of service life indicator (ESLI) or a change schedule based on empirical data (not just in response to contaminant odor, taste or irritation). The 3M Service Life Software (www.3M.com/SLS) may be used to help determine change schedules for 3M gas/vapor cartridges. Air monitoring results, along with temperature, humidity and work rate or PAPR type are entered to estimate cartridge service life. Please also see 3M Technical Data Bulletin #244: Cartridge Change Schedules for Low Exposure Environments.

Conclusion

Hazard assessment and personal exposure monitoring are the first steps in respirator selection and determining cartridge change schedules to help keep workers safe. Air sampling methods must be chosen to match both the contaminant, sampling time and relevant exposure limit. 3M diffusion monitors may be used for sampling many organic vapors, ethylene oxide and formaldehyde. The 3M Respirator Selection Guide may be used to help interpret sampling results, and 3M Service Life Software may be used to estimate cartridge service life.

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