CONOCO

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Subject A Comparative Field Study of Passive Dosimeters with Charcoal Tubes

Summary

The purpose of this study was to evaluate in the field and Laboratory the passive dosimeters commercially available and select the dosimeter which agrees most favorably with the charcoal tube.

Conclusions

1) The 3M and duPont model dosimeters are superior to the Abcor Gasbadge and REAL Minimonitor.

2) The 3M dosimeter is slightly superior to the duPont dosimeter for 1,2 dichloroethane measurement.

3) The analytical method in use is adaptable for use with passive dosimeters and meets OSHA precision requirements.

Recommendation

It is recommended that either 3M or duPont passive dosimeter be chosen for VCM monitoring in all Conoco Chemical VCM and PVC plants.

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A COMPARATIVE FIELD STUDY OF PASSIVE DOSIMETERS WITH CHARCOAL TUBES

Introduction

The objective of this project was to establish and validate a passive dosimeter monitoring system for routine personnel monitoring. The passive dosimeter system is intended to replace the dynamic monitoring system using a 3-inch x 0.25-inch O.D. tube containing approximately 0.4 grams charcoal with air being drawn through the tube at a calibrated rate by a Sipin pump.

Passive dosimeters may be constructed to operate by either permeation or by diffusion principles. The permeation dosimeter has a membrane which will adsorb solvent vapors from the air and release them to the charcoal contained in the interior of the dosimeter. The diffusion dosimeter uses a porous membrane to limit the free flow of solvent vapors from the exterior of the dosimeter to the charcoal pad in the interior. In both cases the rate of transfer depends upon the difference in concentration of solvent vapor between the exterior of the dosimeter and the interior. The concentration of solvent vapors at the surface of the charcoal pad is close to zero. The concentration difference provides the means of operation for the passive dosimeter, no mechanical air mover is necessary. Passive dosimeters are small and light making the device convenient to clip to a collar to monitor a person's breathing zone.

The dynamic monitoring system requires a mechanical pump to move air through the charcoal filled tube. The system then is a charcoal filled tube clipped to the collar and attached by a plastic tube to the pump which is hung on the belt at waist level. The system has the disadvantages of requiring regular pump maintenance and calibration, pump noise, and the inconvenience of the plastic tube catching on objects and restricting movement.

Experimental

The charcoal used for the charcoal tubes was PCB 12 x 30 mesh and was activated at 250^{o}C under 200 cc/min. helium flow. The Minimonitors used charcoal supplied with the dosimeters, 20 x 40 mesh activated at 350^{o}C under nitrogen.

The N,N-dimethylacetamide (DMA) was Fisher certified grade supplied by Fisher Scientific Company. The DMA was regularly checked for contamination. All standard gases were of certified composition supplied by Scott Environmental Technology, Inc. and Big Three Industries, Inc.

An exposure chamber of exposing the dosimeters to standard gas mixtures for predetermined periods of time was constructed from plexiglass (8½ in. x 8½ in. x 2½ in.). The lid was sealed using plastic tape during exposures. Fittings were built into the lid so charcoal tubes could be used to sample the chamber contents. A Bendix air sampling pump, type C-115, was used to recirculate part of the gas and increase the velocity of the gas through the chamber to approximately 35 fpm as measured by an Anemotherm Air Meter. The fittings and tubing were 1/4 inch stainless steel except for short pieces of rubber tubing necessary to connect the glass bubblers. The standard gas entered through a water bubbler to maintain relative humidity in the chamber between 70 to 75%. The exposure apparatus is shown in Figure 1.

The charcoal from a tube or dosimeter was transferred to a 24 cc vial, capped with a rubber septum and a crimp-type cap. The vials were then stored in a freezer at -20°C until ready for analysis. To prepare for analysis the vials were allowed to warm to room temperature and precisely 2 cc of N.N-dimethyl-acetamide (DMA) were added by syringe as the desorbing solvent. The Gasbadge required 5 cc DMA and the Minimonitor 3 cc DMA to wet the charcoal.

The vials were placed in the carrousel of a Perkin-Elmer F-42 Head Space Analyzer along with calibration samples. The carrousel was maintained at 90°C by circulating silicone oil from a constant temperature bath. The vials were allowed to equilibrate for one hour before analysis. Calculations were performed by a Spectra-Physics SP-4000 computer.

Four types of passive dosimeters were available for evaluation. The Gasbadge manufactured by Abcor Development Corporation, the Pro-Tek Organic Vapor Badge by E. I. duPont deNemours and Company (Inc.), the Minimonitor by Reizner Environmental and Analytical Labs, Inc. and the Organic Vapor Monitor by Minnesota Mining and Manufacturing Company (Inc.). The project was designed to determine the best system for plant use and validate the system chosen.

The procedure used was to have plant personnel wear each of the passive dosimeters as well as the charcoal tube and pump during normal work routine. After analysis of the samples the dosimeter results could be compared to the charcoal tube results or to each other for in plant exposures obtained. Vinyl chloride and 1,2 dichloroethane were chosen as the most desirable chemical exposure to examine statistically to test the passive dosimeters.

The results for vinyl chloride and 1,2 dichloroethane are tabulated in Table I to the nearest tenth of a ppm. The lack of precision of the mechanical pumps limited the significance of the data to this level.