Comparison Between a Passive Organic Vapor Monitor (OVM) and a Charcoal Tube for Monitoring Benzene, Ethyl Benzene, Toluene and Xylene

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Introduction

Due to increased awareness of the toxicity of organic substances, government organization, such as the Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH), have continually decreased the permissible exposure limits of many organic substances. For example, in the last ten years, the permissible exposure limit for benzene has been lowered from 10 to 0.1 ppm. This has lead to an increased demand for sampling methods and devices capable of measuring these low concentrations. Although passive diffusive methods have been used for more than a decade, there is still hesitation about their performance as compared to the tube/pump method.

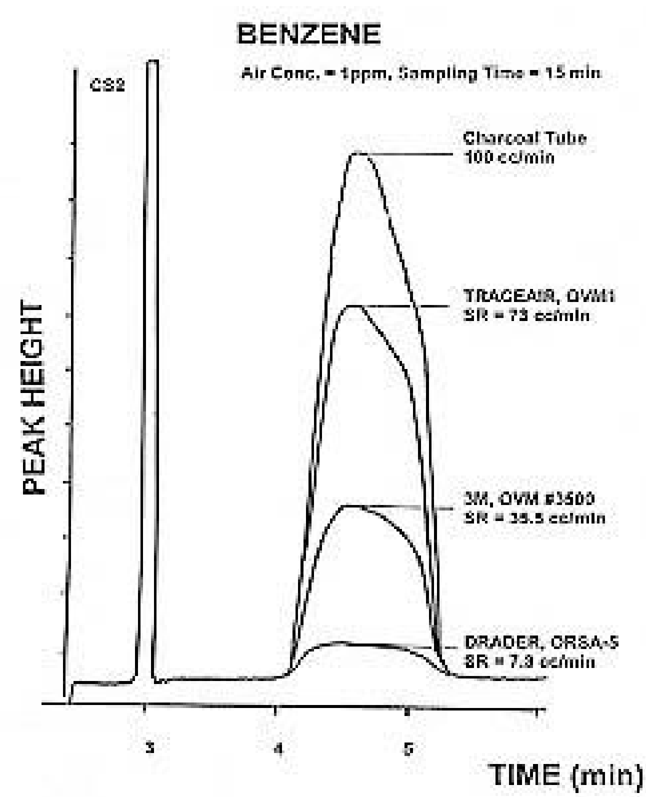
A comparison study was conducted between the traditional active charcoal/pump method and a diffusive organic vapor monitor (OVM). Four substances were evaluated: benzene, toluene, ethyl benzene and xylene.

Objectives

1. To prove the ability of a passive diffusive OVM to serve as a simple, accurate , cost effective alternative to the tube/pump method. The OVM avoids the following drawbacks of the tube/pump method:
    - •The tube/pump method requires highly trained personnel to (1) maintain and calibrate air sampling pumps and (2) prepare for testing.
    - •In many work situations, wearing a sampling pump and connection tubing impairs worker performance.
    - •The average cost per tube/pump sample is high
2. To find an alternative device capable of accurately measuring low concentrations.

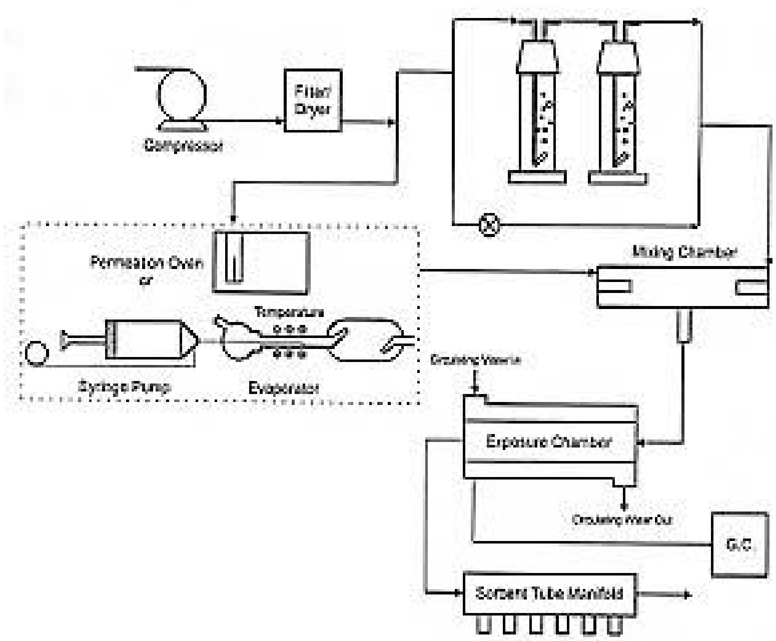
In recent years, NIOSH acknowledged the use of passive organic monitors as an alternative to the tube/pump method with the development of NIOSH Method 40001. Several passive monitors are described in this method. To measure low concentrations, a passive monitor should posses high sampling rates comparable to the active method. The GC response of three OVM's exposed simultaneously to benzene is depicted in Figure 1.

Figure 1: Benzene



Experimental

Materials: Standard coconut charcoal tubes (100 mg front and 50 mg back section) were used throughout the study in conjunction with the Gilian sampling pump Model LFS-113. TraceAir organic vapor monitors were used as a representative of diffusive samplers. Benzene, toluene, ethyl benzene and xylene vapors were generated in a dynamic vapor generating system; a schematic diagram is depicted in figure 2. Vapor concentrations were verified with an independent method using on-line SRI Model 8610 GC. Significant data was considered when the generated and verified concentrations were within ±5% agreement.



Methods

- In the laboratory testing, TraceAir OVM-2 monitors were used to ensure breakthrough did not occur. Five badges were used in each experiment. Testing was conducted at 80% RH and 25°C. The only influence that water vapor has on the TraceAir badges is that is competes for active sites on the charcoal *i.e., it affects the capacity). Therefore, performance parameters measured at 80% RH will be valid or superior to any humidity conditions below 80% RH (Figures 3 to 7).
- Field testing was setup to monitor for benzene vapors. TraceAir OVM-1 monitors and stan dard charcoal tubes were exposed simultaneously. Thirty-four pairs of the monitoring devices were used in the procedure. sampling times varied from 13 to 690 minutes, and concentra tions ranged from 0.004 to 6.62 ppm (figure 8)

Figure 3

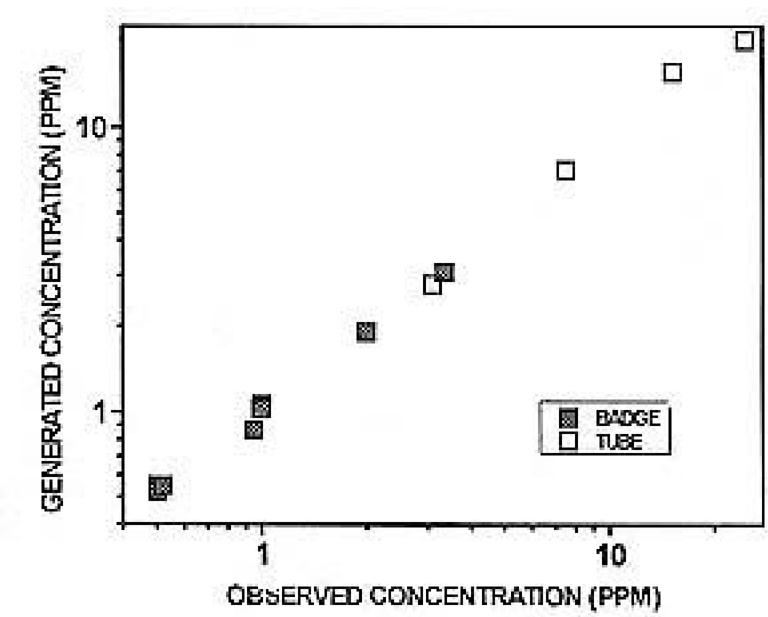


Figure 4

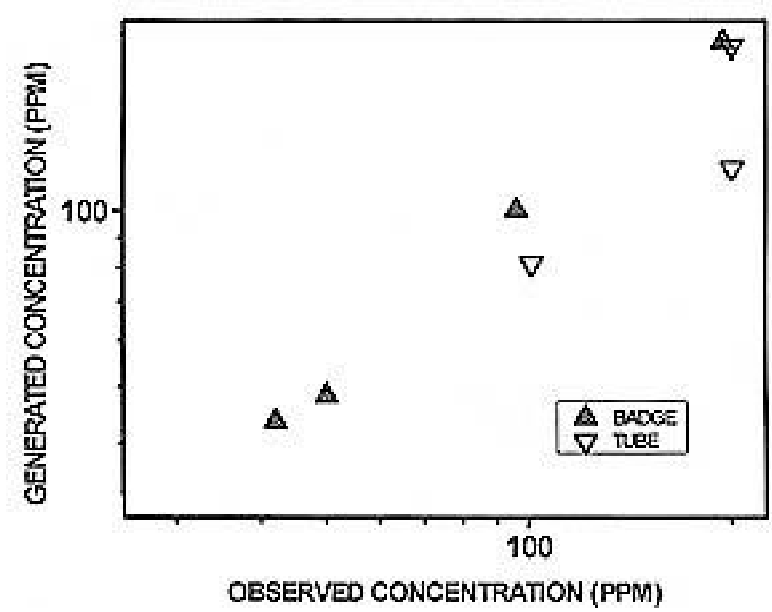


Figure 5

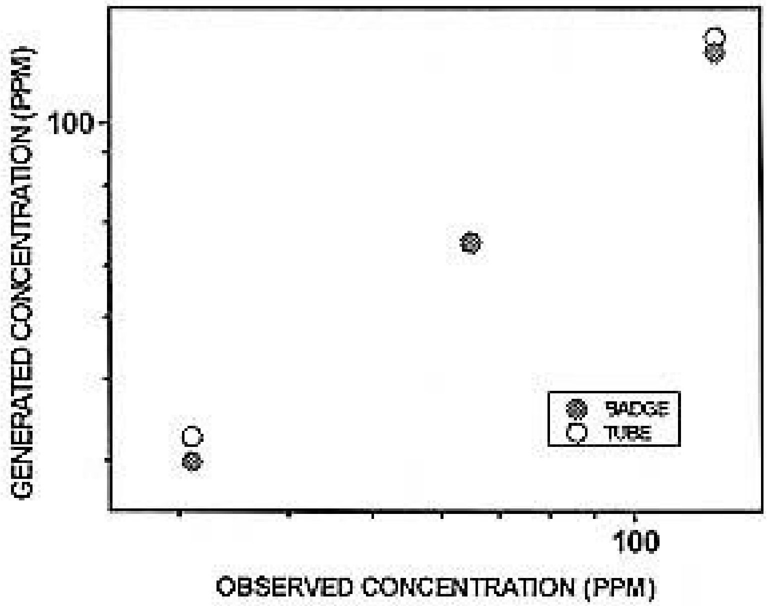


Figure 6

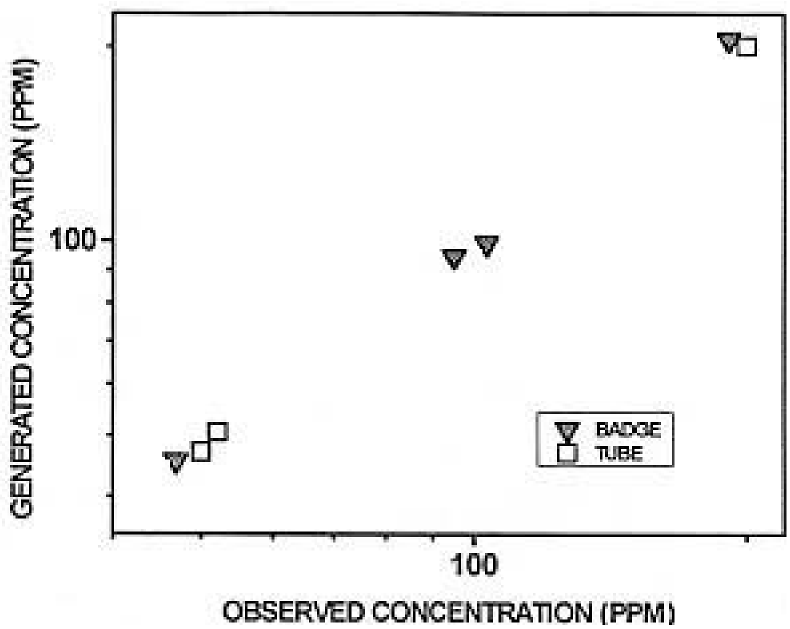


Figure 7

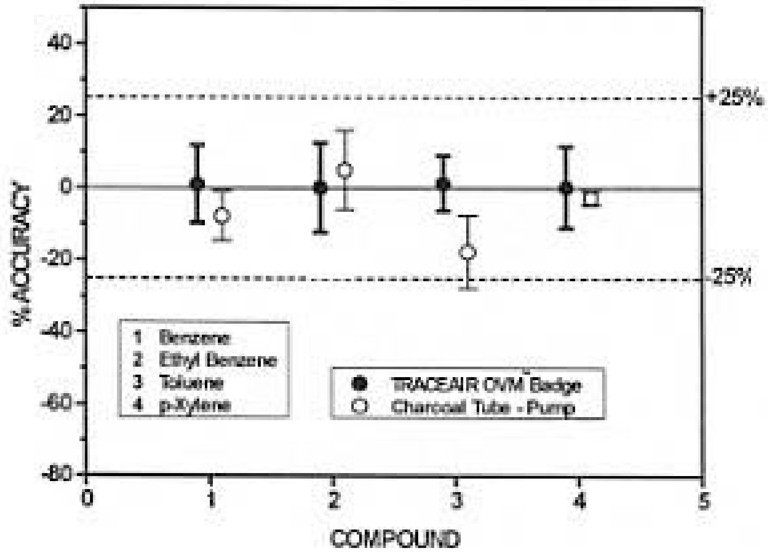
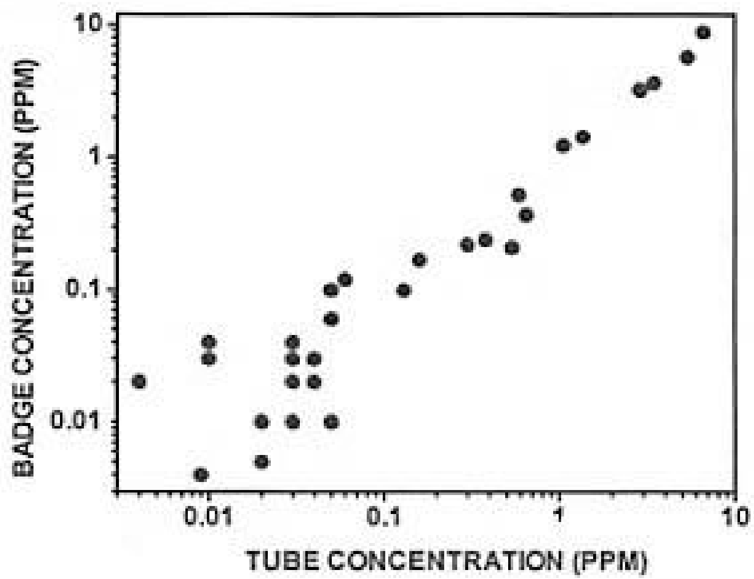


Figure 8



Conclusion

	OVM		Tube	
Compound	**Bias**	**Overall Accuracy**	**Bias**	**Overall Accuracy**
Benzene	4.6	9.4	7.8	14.6
Ethyl benzene	0.1	12.5	5.0	16.0
Toluene	3.7	7.9	17.7	27.7
p-Xylene	0.09	4.7	2.8	4.2

References

1. Woebkenberg, M. L.,: Toluene (passive) NIOSH Method 4000. NIOSH Manual of Analytical Methods (NMAM) Fourth Edition, Aug. 15, 1994.
2. Cassinelli, M., Hull, R., Crable, J. and Teass, A.: Protocol for Evaluation of Passive Monitors. National Institute for Occupational Safety and Health, Ohio.
3. Nelson, G. O.: Controlled Test Atmospheres. Ann Arbor Science, Michigan (1982).
4. Woodfin, W.: Gas and Vapor Generating Systems for Laboratories. U. S. Department of Health and Human Services, Ohio (1984).
5. Duncan, A. Ph.D.: Quality Control and Industrial Statistics. Richard D. Irwin, Illinois (1953).
6. Lautenberger, W. Ph.D., Kring, E. Ph.D., and Morello, J. Ph.D.: A New Personal Badge Monitor for Organic Vapor. Am. Ind. Hyg. Assoc. J. 41:737-747 (1980).
7. TraceAir System, Laboratory and Field Validation Report. Aromatics, Gilian Environmental, Corp. (Feb. 1993).
8. TraceAir System, Technical Reference Guide, Gilian Environmental, Corp. (1993).

Acknowledgments

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