SLIDE

TEXT

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2. My name is Jim Kivkstad. I am with the Occupational Health & Safety Products Division of the 3M Company. Today, I would like to take a few minute to briefly discuss the concept of diffusional monitoring for organic gases and vapors.

3. 3M entered the diffusional sampling field in 1974 with the Mercury Vapor Monitor #3600. This monitor is now included as the method recommended and specified for sampling mercury by the OSHA Field Operating Manual. Patents were issued on this product on December, 1975 and on April 1976.

4. In 1978 the second diffusional monitor was introduced; the 3M Organic Vapor Monitor #3500. This product was patented in July, 1978.

5. A sister product introduced in 1981 is the 3M Organic Vapor Monitor #3520. This is an organic vapor monitor with a back-up section, which provides assurance of the sample validity for organic compounds with high vapor pressures. The design of this product allows for ~~immediate~~ separation of front and back sections. ~~Upon completion of sampling, while maintaining~~ the ? ~~absorption feature. Thus, any migration of highly volatile compounds is eliminated, so sample validity~~

~~conclusions can be drawn~~.

6. Continually expanding ~~their~~ THE product line, next followed the 3550 Ethylene Oxide Monitor. This monitor formed a ~~de~~rivitive of the Ethylene Oxide during ~~absorption~~ ADSORPTION so that it features a sample storage stability greater than sixty days at room temperature; in contrast to the refrigeration and prompt analysis requirement by two methods now available. Usually they must be analyzed within 24 hours.

3550 EtO MONITOR

7. Lightweight and badge size, the Ethylene Oxide Monitor is worn on the lapel or collar by the worker for the entire sampling period just like the other diffusional samplers in the line.

3550 EtO MONITOR ON LAPEL

8. As with the other diffusional samplers, the ~~the~~ plastic case serves as a vessel to hold the disorbing solvent, eliminating any handling of the ~~absorbent~~ ADSORBENT wafers.

3550 BROKEN DOWN INTO PARTS

9. The 3M Formaldehyde Monitor #3750 uses the NIOSH accepted ~~chromotroetic~~ CHROMOTROPIC acid technique for analysis. However, this technique has been modified to minimize interferences from phenol. The sampling rate and capacity of this monitor also allows a measurement of low concentratio of formaldehyde in the home, while still being able to accommodate industrial applications up to 7 X the PEL for 8 hours before exceeding its capacity.

3750 FORMALDEHYDE MONITOR

10. Currently the Carbon Monoxide Monitor #3400 is our only direct read device.

11. This product is also worn on the lapel, and allows the diffusion of Carbon Monoxide through the windscreen and into the sorbent material.

12. When the Carbon Monoxide Monitor is removed from the sealed pouch, the color indicator is a bright pink in color.

13. As it approaches the end point of 340 ppm hours, it begins to turn from pink to tan. The tan color ~~being~~ is the same as the outside ring of the monitor.

14. Upon completion of the end point, the color is now completly tan.

15. ~~In the example~~ An illustration of what the Carbon Monoxide looks like before and after exposure. This indicates that a dose of 340 ppm-hours of carbon monoxide has been absorbed by this diffusional monitor.

16. Thus, the concept of diffusional monitoring with its inherent advantages of simplicity of use, low expense, and reliability have led to ready market acceptance and a ever-expanding product line.

17. Let's recall for a moment the significant difference between a pump and tube (~~or~~ impinger) and a diffusional sampling device. Aside from the obvious differences of size and weight, ease of use, and cost, there are ~~other~~ ~~also~~ significant differences in the way the contaminant reaches the sorbent material.

18. In the tube or impinger, relying upon a mechanical pump, the contaminant and air are mechanically pulled through a tube at a set flow rate ~~of~~ by the pump. In the diffusional sampler, the contaminant only moves from an area of higher concentration to an area of lower concentration, at a rate dependent on each ~~contaminant~~ vapors diffusion coefficient.

19. In both cases we depend upon the air currents in the environment to carry the contaminant to the mouth of the tube or the windscreen of the diffusional monitor. In the 3M diffusional monitor, the windscreen, which is 90% void space, simply serves to ensure that the space between the windscreen and the sorbent is stagnent. Thus, we are depending entirely upon diffusion to transport the organic vapors from the windscreen to the sorbent material.

20. Before proceeding with the discussion of the diffusion monitors let's talk a little bit about the process of diffusion.

21. The process of diffusion is ~~covered~~ by Fick's Law, which states very simply that the flow of material (J) is dependent upon a ~~duffision~~ coefficient (which is specific for each individual compound) multiplied by the concentration gradient.

22. In other words, the material will flow from an area of high concentration to an area of low concentration. If we integrate Fick's Law, and make the assumption that the concentration of organic vapors at the windscreen (C_a) is the same as the concentrations in the breathing zone; and the further assumption that the concentration is zero at the surface of the sorbent, then we can solve the equation and get the result that the amount of material ~~absorb~~ (W) will be equal to the diffusion coefficient (D) multiplied by the area of the sampler (A) and divided by the path length (L). All of this multiplied by the concentration at the windscreen and the time. Rearranging we can lump the diffusion coefficient, the area and the length into a constant which is called (K) the sampling rate of contaminant. You can then solve the ~~equasion~~ for (C), the concentration in the air. ~~which equals~~ (W) ~~which~~ can be measured in the analytical ~~which can be measured by analysis divided by K times~~ T.

23.

24. In order to determine the accurate concentrations, the sampling rate for each contaminant will have to be determined very accurately

hit the bullseye. Additionally, to be valid, a sampling device must have a high degree of precision. That is, all values must lie very close to each other, with a low coefficient ~~variant~~ OF VARIANCE.

25 VALIDATION OF SAMPLING RATE

At the 3M laboratories, a minimum of 30 samples are used to get a value for the sampling rate. As shown in this ~~octane~~ example, octane is sampled from challenges from approximately 0.1, 0.5, 1, 2, and 4 x its PEL by six monitors at each concentration. Typically the value has a coefficient of variance of this magnitude. (0.027). In addition to this precision (or reproducability), A comparison must be made to a known to determine how accurate the sampler is.

26. CALIBRATION OF SAMPLING RATE MUSIC

27 ACCURACY DETERMINATION HEXANE

Here is an example of Hexane in which the sampling rate has been determined to be 32.8 cc per minute. When compared to a primary standard of 1002 ppm, the 3M Organic Vapor Monitor showed a value of 975 ppm and an error of only 2.7%. Recall that just because of the variances inherent in a pump, OSHA assigns a value of + or - 5% for the sampling pump, alone.

28 ~~[illegible]~~ SAMPLING RATE VS D

For the Organic Vapor Monitor, which can be used for over 130 compounds, sampling rates have been determined in a manner just described for over 65 compounds. In so doing, it was found that the sampling rate versus

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the theoretical diffusion coeffecient relationships varied only enough to assure ± 10% sampling rate accuracy on any sampling rate values that had not been measured, but had to be calculated. However, by separating into families as shown on these three slides, and using the appropriate equation for the theoretical diffusion coefficient, theoretical sampling accuracies can be determined within plus or minus 5% of their true value.

It can be observed that the technical data available showed that the calculated diffusion coefficient can yield a sampling rate for the user which will provide accurate concentrations of air contaminants.

An obvious question at this point would be how well does a diffusional sampler correlate to the accepted method of the pump and charcoal tube.

Extensive work has been done, both in the laboratories and in the field, both by 3M and by independent agencies to correlate relationships between diffusional samplers and other methods of measuring concentrations. In this first example, the technical research center of Finland used four methods to assess concentrations:

1. The Wilkes Infrared method.
2. A gas ~~chemetograph~~. CHROMATOGRAPH
3. Pumps and charcoal tubes.
4. The 3500 Organic Vapor Monitor.

When sampling a single contaminant, ~~tolyene~~ TOLUENE in this case, for four hours at two levels, good agreement was demonstrated for all methods.

~~26.~~ 33 FIELDS STUDY This particular slide shows the results of the 3500 Organic Vapor Monitor.

~~27.~~ ~~33~~ 34 FIELDS STUDY Short-term samples were taken also by three of the methods with the following result.

~~28.~~ 35 FIELDS STUDY How about mixtures? A mixture of ~~isobutal~~ ISO BUTYL alcohol and ~~tolyene~~ TOLUENE was sampled by all four methods. Here is a comparison of the tubes with the infra red and GC.

~~29.~~ 36 FIELDS STUDY Next, note the results of the 3500 Organic Vapor Monitor with the two accepted methods. Good agreement with accepted methods ~~and~~ IN well designed experiments in which capacity is not exceed, is typical of results obtained with the diffusional samplers.

~~38~~ 37 GASOLINE EXPOSURE TEST IN THIS GASOLINE EXPOSURE TEST - NOTE THE LOW STD DEVIATION OF THE 3500 TESTS

~~30.~~ ~~37~~ 38 ~~What about relative humidity and temperature~~? 3M 001141

~~38~~ 39 NOTE THE GOOD CORRELATION BETWEEN

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