assay technology

Laboratory Evaluation of AT543 Diffusive Air Sampler using dynamically-generated Acetic Acid Test Atmospheres

in accordance with guidelines described in ANSI/ISEA 104-1998 (R2009)

Prepared by: C.R. Manning, PhD, CIH Date: 30 August 2013

These tests for Evaluation of Diffusive Air Samplers were conducted within the guidelines described in ANSI 104-1998 (R2009).

1. Test Apparatus & Method

Vapor exposures of Acetic Acid (HOAc) were created by dynamic dilution from a liquid phase containing the pure analyte (glacial acetic acid). The liquid analyte was injected into a flowing stream of air at a fixed rate via a syringe pump (Harvard), then dynamically mixed with flow-controlled input air provided by the Miller-Nelson 401 atmosphere conditioner. The controlled mixture was passed through an inert acrylic chamber containing Diffusive Samplers under test. Flows were verified by calibration, and exposure concentrations were verified by charcoal tube samplers mounted in the chamber and bracketing the Samplers under test. Active and diffusive samplers were eluted using an aqueous solution of sodium borate and analyzed by Ion Chromatography using a method similar to OSHA ID-186SG.

2. De-Sorption Efficiency (DE)

Analyte recovery (de-sorption efficiency) was determined by analysis (Method AT543) of charcoal wafers "spiked" from standard analyte solutions. Samplers were tested at "spike" levels corresponding to expected levels of exposure in the vicinity of the OSHA PEL. DE Results are presented in Table 1.

3. Verification of Diffusive Sampling Rate

Samplers were exposed to exposure concentrations in Chambers as described above, then analyzed by Method AT543. Exposures were applied to Samplers in the vicinity of the OSHA PEL. Results for acetic acid (HOAc) are reported in Tables 2A and 2B.

4. Background (Blank) Determination

Unexposed Samplers analyzed by Method AT543 to determine background Analyte levels (if any) on the Sampler prior to sampling. No background peaks were detectable (< 0.1 μg).

5. Effects of Air Velocity & Orientation

Samplers were exposed to atmospheres for 2-4 hrs at 1-2 times the OSHA PEL in a Chamber such that linear velocities of 15, 50, and 150 cm/sec, respectively, were generated. Samplers were placed in each zone with *50% of samplers placed normal to* and *50% of Samplers perpendicular to* the flow direction. When data from different locations and flows were compared (representing normal air velocity and orientation variation in workplaces), no significant differences were found among the groups indicating the *absence of a significant effect of Air Velocity & Orientation on Sampling Rate*. This test, performed previously on the Sampler using analytes other than the ones in this study, was not repeated in this study.

6. Effect of Temperature & Humidity

Samplers were exposed to atmospheres for 2-4 hrs at 1-2 times the OSHA PEL in several Chamber runs in which nearly identical exposures were applied with variations in temperature and humidity as follows: 22°C/50%RH, 10°C/50%RH, 30°C/30%RH, 30°C/70% RH. Data from the four conditions (representing normal temperature & humidity variation) showed no significant differences among the groups indicating the *absence of an effect of Temperature & Humidity on Sampling Rate in the range 10-30°*C and 30-70% RH. This test, performed previously on the Sampler using analytes other than the ones in this study, was not repeated in this study.

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7. Bias Due to Reverse Diffusion

Samplers were subject to an Exposure Pulse in the vicinity of the OSHA PEL with duration of 25% of the Recommended Sampling Time (RST). Half of exposed Samplers were then subject to a Zero Exposure Period (ZEP) for the duration (75%) of the RST, while the other half were analyzed immediately (or stored at -20^{o}C until analysis). Recovery of analyte from Samplers subject to the ZEP were compared with recovery of analyte from Samplers analyzed immediately. Any difference between these two recoveries is taken as the extent of Reverse Diffusion.

For Samplers subject to a Zero Exposure Period of 6.5 hours, recoveries were equal to or greater than 100% compared to Samplers analyzed immediately after Exposure. Thus, no significant Bias Due to Reverse Diffusion was observed. Results are shown in Tables 3.

8. Sampler Package Integrity

Ethylene Oxide Samplers (Monitor 502) in sealed packaging exposed to >10 ppm ethylene oxide for >2 hours, then analyzed as directed in the Instructions for Use. Results from analysis were not significantly different from results for un-exposed Samplers (blank values) demonstrating the integrity of Sampler packaging. This result with ethylene oxide (which has highest permeability through plastics and pinholes of all analytes tested) is applicable to all Samplers manufactured by Assay Technology and packaged in its standard aluminum foil pouch.

9. Summary Comments

Sampler AT543 has been evaluated for sampling acetic acid (HOAc). The overall system accuracy expressed as Maximum Total Error (95% confidence) is estimated at $\leq$ 25 %

Concentration Range	0.1-2.0 times the OSHA PEL of 10 ppm
Sampling Time	0.25 - 8 hour
Air Velocity	15-150 cm/sec
Temperature	Room Temperature
Humidity	10-80% RH

It is recommended that Sampler 543 be used within the envelope of conditions specified above, but, in general, minor excursions outside these limits would be expected to have only minor effects. Longer or shorter sampling times are possible but have not been evaluated.

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Table 1
De-Sorption Efficiency
(Recovery of Acetic Acid from Sampler using OSHA Method ID-186SG)

Qty Applied (µg)	2.17	**% Recovery**
Qty Recovered (µg), Trial 1	2.15	98.8%
Qty Recovered (µg), Trial 2	2.22	102.2%
Qty Recovered (µg), Trial 3	2.41	110.9%
Qty Recovered (µg), Trial 4	2.33	107.2%
Average	2.28	104.8%

Qty Applied (µg)	5.00	DE:
Qty Recovered (µg), Trial 1	4.82	96.4%
Qty Recovered (µg), Trial 2	4.08	81.5%
Qty Recovered (µg), Trial 3	4.07	81.5%
Qty Recovered (µg), Trial 4	3.79	75.8%
Average	4.19	83.8%

Qty Applied (µg)	7.58	DE:
Qty Recovered (µg), Trial 1	7.86	103.6%
Qty Recovered (µg), Trial 2	7.64	100.7%
Qty Recovered (µg), Trial 3	7.64	100.8%
Qty Recovered (µg), Trial 4	6.95	91.7%
Average	7.52	99.2%

% Recovery (Grand Average) = **96%**

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Table 2A
Verification of Sampling Rate
(in the vicinity of 5 ppm 8 hr TWA)

Sample ID	Sampler Exposure & Post-Treatment	8 hr TWA Equivalent (ppm)	Sampling Time (min)	Reference Concentration (sampling tubes) (ppm)	HOAc Found on Sampler (µg)	Concen Found by Badge (ppm)	Comparison to Ref Value (% Recovery)
2013031294	40 ppm, analyze immed.	5	60	51.8	45	53.8	104%
2013031295	40 ppm, analyze immed.	5	60	51.8	45	55.1	106%
2013031296	40 ppm, analyze immed.	5	60	51.8	48	57.7	111%
2013031297	40 ppm, analyze immed.	5	60	51.8	50	60.3	116%

Table 2B
Verification of Sampling Rate
(in the vicinity of 10 ppm 8 hr TWA)

Sample ID	Sampler Exposure & Post-Treatment	8 hr TWA Equivalent (ppm)	Sampling Time (min)	Reference Concentration (sampling tubes) (ppm)	HOAc Found on Sampler (µg)	Concen Found by Badge (ppm)	Comparison to Ref Value (% Recovery)
2013031302	55 ppm; analyze immed.	10	90	79.8	110	85.9	108%
2013031303	55 ppm; analyze immed.	10	90	79.8	110	92.3	116%
2013031304	55 ppm; analyze immed.	10	90	79.8	110	87.2	109%
2013031305	55 ppm; analyze immed.	10	90	79.8	120	97.4	122%

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Table 3
Assessment of Reverse Diffusion
(Assessment of Sample Loss Due to re-Evaporation)

Sample ID	Sampler Exposure & Post-Treatment	8 hr TWA Equivalent (ppm)	Sampling Time (min)	Reference Concentration (sampling tubes) (ppm)	HOAc Found on Sampler (µg)	Concen Found by Badge (ppm)	Comparison to Ref Value (% Recovery)
2013031273	60 ppm; analyze immed.	15	120	74	120	70.5	95%
2013031274	60 ppm; analyze immed.	15	120	74	120	71.8	97%
2013031275	60 ppm; analyze immed.	15	120	74	120	70.5	95%

Sample ID	Sampler Exposure & Post-Treatment	8 hr TWA Equivalent (ppm)	Sampling Time (min)	Reference Concentration (sampling tubes) (ppm)	HOAc Found on Sampler (µg)	Concen Found by Badge (ppm)	Comparison to Ref Value (% Recovery)
2013031278	60 ppm for 2hr, followed by 6.5 hours at Zero Exposure	15	120	74	110	67.9	92%
2013031281	60 ppm for 2hr, followed by 6.5 hours at Zero Exposure	15	120	74	110	65.4	88%
2013031282	60 ppm for 2hr, followed by 6.5 hours at Zero Exposure	15	120	74	120	73.1	99%