Air Sampling of VOCs Using New SPME Portable Field Sampler

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With the development of two new products, the solid phase microextraction (SPME)* technology now can be applied to air sampling and monitoring. These products — an SPME portable field sampler and an SPME fiber coated with 75µm of Carboxen™/polydimethylsiloxane (PDMS) — allow analysis of volatile organic compounds (VOCs) at trace levels.

- The SPME portable field sampler eliminates the need to ship samples from the field to the lab. When the needle containing the fiber is sealed by the self-contained septum, there is no loss of analytes from the fiber prior to desorption. Consequently, the fiber need not be desorbed immediately after extraction.
- The Carboxen/PDMS fiber efficiently extracts and retains VOCs at trace levels, yielding good linearity. The pore structure of the Carboxen material enables the fiber to extract a variety of analytes in a complex mixture, with minimal displacement.

Using a mixture of 9 VOCs, we attempted to determine the capacity of the Carboxen/PDMS fiber, and to determine whether analytes with low distribution constants would be displaced by analytes with higher distribution constants. The analytes were obtained from a 1ppm gas stream and spiked into a 125mL bulb with a final concentration ranging from 400ppt to 400ppb. Using an SPME portable field sampler containing a Carboxen/PDMS fiber, the analytes were extracted for 10 minutes at ambient conditions. Figure A shows the analytes at 10ppb.

Figure B shows the concentration plots for three analytes. Excellent linearity is indicated by the correlation coefficients of 0.98 or higher. Of the 9 VOCs, only 1,2-dichloroethane yielded a value less than 0.98 (Table 1). Vinyl chloride and 1,3-butadiene had the lowest distribution constants, which tetrachloroethene and trichloroethene had the highest.

Classical adsorption mechanism theory suggests that, due to limited adsorption sites, the lighter analytes will be displaced by the heavier analytes as concentration increases. At concentrations above 400ppt, the amount of analyte extracted would level off. However, the unique pore structure of Carboxen-1006™ material enables extraction of all analytes without displacement of the lighter analytes.

The portable field sampler and the Carboxen/PDMS fiber are an ideal combination for monitoring air samples. The ability to collect both air and water samples in the lab or field with the sampler and analyze at a later time is convenient, simple, and reliable for trace level analyses.

Table 1. Correl. Coef. for VOCs

<table>
<thead>
<tr>
<th>Analyte</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vinyl chloride</td>
<td>0.980</td>
</tr>
<tr>
<td>1,3-Butadiene</td>
<td>0.990</td>
</tr>
<tr>
<td>Acrylonitrile</td>
<td>0.980</td>
</tr>
<tr>
<td>Methylene chloride</td>
<td>0.986</td>
</tr>
<tr>
<td>Chloroform</td>
<td>0.984</td>
</tr>
<tr>
<td>1,2-Dichloroethene</td>
<td>0.953</td>
</tr>
<tr>
<td>Benzene</td>
<td>0.995</td>
</tr>
<tr>
<td>Trichloroethene</td>
<td>0.982</td>
</tr>
<tr>
<td>Tetrachloroethene</td>
<td>0.990</td>
</tr>
</tbody>
</table>

Figure A. VOCs in Air at 10ppb

Sample: VOCs in air at 10ppb, 125mL bulb
SPME Fiber: Carboxen/PDMS, 75µm film
Cat. No.: 57318
Extraction: headspace, 10 min
Desorption: 5 min, 300°C
Column: SPB™-1 SULFUR, 30m x 0.32 mm ID, 4.0µm film
Cat. No.: 24158
Oven: 40°C (2 min) to 150°C at 8°C/min
Carrier: helium, 35cm/sec
Inj.: splitless (closed 2 min), 0.75mm ID liner
Det.: GC/MS ion trap, m/z = 45 - 260

Figure B. Linear Analyte Response Using Carboxen/PDMS Fiber

10 min extraction

Acrylonitrile
1,3-Butadiene
Vinyl chloride

Concentration (ppb)

0 100 200 300 400

Response (10⁵)

0 10 20 25

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