Reprinted from Analytical Chemistry, 1995, *67*.

Water Adsorption Capacity of the Solid Adsorbents Tenax TA, Tenax GR, Carbotrap, Carbotrap C, Carbosieve SIII, and Carboxen 569 and Water Management Techniques for the Atmospheric Sampling of Volatile Organic Trace Gases

Detlev Helmig* and Lee Vierling

National Center for Atmospheric Research, Boulder, Colorado 80307-3000

The solid adsorbents Tenax TA, Tenax GR, Carbotrap C, Carbotrap, Carbosieve SIII, and Carboxen 569, all of which are commonly used for sampling of volatile organic compounds (VOCs) from the atmosphere, were tested for their capacity to trap water vapor by a new experimental approach. Instead of performing breakthrough measurements, water uptake was determined gravimetrically until saturation. Test atmospheres at 10, 20, 30, and 40 °C and 20, 40, 60, 80, and 100% relative humidity (RH) in a temperature (*T*)- and humidity-controlled climate chamber were collected onto sampling cartridges containing beds of the above-listed adsorbents. This technique allowed us to obtain information on the dependency of the water uptake on sampling volume, *T*, and RH and to deduce strategies for water management. Tenax TA, Tenax GR, Carbotrap, and Carbotrap C showed low water trapping of generally less than ~2−3 mg of water/g of adsorbent under the highest humidity conditions tested. In contrast, the carbon molecular sieve type adsorbents Carboxen 569 and Carbosieve SIII exhibited substantially higher water trapping capacity, with up to ~400 mg of water/g of adsorbent under the highest RH conditions tested. For Carboxen 569 and Carbosieve SIII, water saturation occurs relatively slowly; the water saturation point is reached only after the sampling of volumes that are much higher than typical volumes collected in ambient VOC sampling. For both of these adsorbents, it was shown that the amount of water adsorbed at a given temperature depends mainly on the RH levels. For a multibed adsorbent cartridge, the overall water adsorption could be calculated reasonably from the expected contributions of the individual components. Possible measures for minimizing the amount of water trapped are, for example, collecting small sampling volumes, minimizing the amount of adsorbent in the sampling tube, moderate heating of the adsorbent tube during sampling, or including a dry purge step before thermal desorption.

(1) Fabbri, A.; Crescentini, G.; Mangani, F.; Mastrogiacomo, A. R.; Bruner, F. *Chromatographia* **1987**, *23*, 856−860.
(2) Wood, G. O. *Am. Ind. Hyg. Assoc. J.* **1987**, *48*, 622−625.
(3) Ciccioli, P.; Cecinato, A.; Brancaleoni, E.; Frattoni, M.; Liberti, A. *J. High Resolut. Chromatogr.* **1992**, *15*, 75−84.
(4) Des Tombe, K.; Verma, D. K.; Stewart, L; Reczek, E. B. *Am. Ind. Hyg. Assoc.* **1991**, *52*, 136−144.
(5) Sturges, W. T.; Elkins, J. W. *J. Chromatogr.* **1993**, *642*, 123−134.
(6) Helmig, D.; Schwarzer, N.; Steinhanses, J. *J. High Resolut. Chromatogr.* **1990**, *13*, 849−851.
(7) Nelson, G. O. *Controlled Test Atmospheres. Principles and Techniques*; Ann Arbor Science Publishers: Ann Arbor, MI, 1971; pp 221.

0003-2700/95/0367-4380$9.00/0