USE OF CARBON MOLECULAR SIEVES FOR SAMPLE ENRICHMENT OF AIRBORNE VOLATILE COMPOUNDS

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Introduction

Carbon molecular sieves have been prepared for use in airborne contaminant sample enrichment applications. Gas-solid chromatography (GSC) was used as a tool for characterizing the carbon sieves to parallel the dynamic adsorption process utilized for sample enrichment (1). The thermodynamic and kinetic properties of the sieves were evaluated to provide insight into the adsorption and desorption properties of the sieves. The data obtained have led to the development of new, efficient adsorbent tubes for application in the air quality industry.

Experimental

A 0.25 in. O.D. x 4.0 mm I.D. glass column apparatus was constructed to retrofit air sampling tubes of similar dimensions into a gas chromatograph (GC). This apparatus consisted of two L-shaped, silanized glass tubes and were used to connect a ten cm tube packed with the adsorbent of interest in the GC (2). The carbon molecular sieve packed bed weights were 0.2500 +/- 0.0002 grams, and nitrogen or helium carrier gas was used at a flow rate of 30 mL/min. to parallel typical air sampling flow rates.

The GC oven temperatures chosen were a function of the adsorbate and adsorbent of interest. Four different oven temperatures were chosen to provide a straight line plot of the specific retention volume versus temperature. Linear regression analyses were used to provide an extrapolated specific retention volume value at ambient temperature.

Results and Discussion

The data obtained from the breakthrough volume experiments for the carbon molecular sieves and activated carbons are presented in Table I.

Table I
breakthrough volume data for
carbon molecular sieves

Adsorbent	Breakthrough volume dichloromethane (L)	Water
Carbosieve S-III	66.2	0.32
Carboxen-569	43.2	0.06
Activated coconut charcoal	39.2	2.44
Carboxen-564	31.5	0.10
Carbosieve S-II	31.5	1.02
Purasieve	5.05	0.24
Carboxen-563	1.56	0.80
Spherocarb	1.05	0.22

The data presented include values for both dichloromethane and water. Dichloromethane was chosen to represent a small molecular sized analyte which would migrate through the sieve bed quickly, relative to other typical airborne hazardous contaminants. Water was chosen to provide insight into the hydrophobicity of the carbon sieves, and is known to behave as a liquid phase which reduces the breakthrough volumes obtained using dry stream sampling experiments.

Further evaluations focusing on the carbon:hydrogen ratio of the carbon sieves have provided insight into the preparation of the sieves. Factors such as starting materials, furnace temperatues and activation processes have been evaluated. Figure 1 illustrates the relationship between carbon:hydrogen ratios and

the breakthrough volumes for eight experimental sieves.

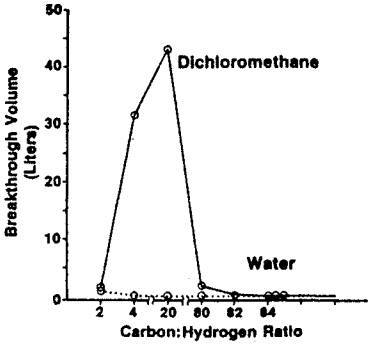

Figure 1. breakthrough volumes of dichloromethane and water as a function of carbon:hydrogen ratio

Conclusion

Gas solid chromatography and inverse gas chromatography have been used as dynamic techniques for understanding the thermodynamic properties of several carbon molecular sieves.

References

1. Kiselev, A.V. and Yashin, Y.A., *Gas Adsorption Chromatography*, New York, NY: Plenum Press, 1969.
2. US Environmental Protection Agency, *Characterization of Sorbent resins for use in Airborne Environmental Sampling*, EPA Document #500/7-78-054, 1978.