Heats of Adsorption of Various Organic Solvents on Activated Carbon Using a Microcalorimeter Equipped with a Perfusion Cell.

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SUMMARY

A common technique for sampling organic solvents in workplace air is the use of preconcentration of vapors on adsorbents. The most widely used adsorbent is activated carbon, due to its large sampling capacity. After desorption (thermal or displacement by other solvents such as carbon disulfide), analysis is made by gas chromatography. In order to avoid breakthrough, the collected amount is usually <10% of the maximum capacity (total pore volume).

An important parameter for characterizing an adsorbent is the heat of adsorption, δH_{ads}. Although it is not independent of coverage degree drastic differences are usually not common if the coverage degree is low. The most widely used techniques for determining the heat of adsorption are gas chromatographic and static methods. In practical work it is often of interest to compare different adsorbents at the same coverage degree (that should be realistic) so that more refined and time consuming methods can be substituted by fast and easy methods.

EXPERIMENTAL

Two activated carbons, Merck Aktivkohle (20—35 mesh, Merck 9624) and SKC (lot 120, SKC Inc. Eighty Four, PA) were used in this study with characteristics displayed in Table 1. The temperature during the measurements was 25 °C. Outgassed carbon (300 mg) was filled in the stirrer turbine (l = 26 mm, D = 7 mm) of the perfusion cell and fitted with a wire netting at the bottom to retain the sample. A simplified method to generate vapors is shown in Figure 1. Two subsequent additions of 3 μl solvent was made in each run. Injections were made after a stable baseline was reached and heats of adsorption

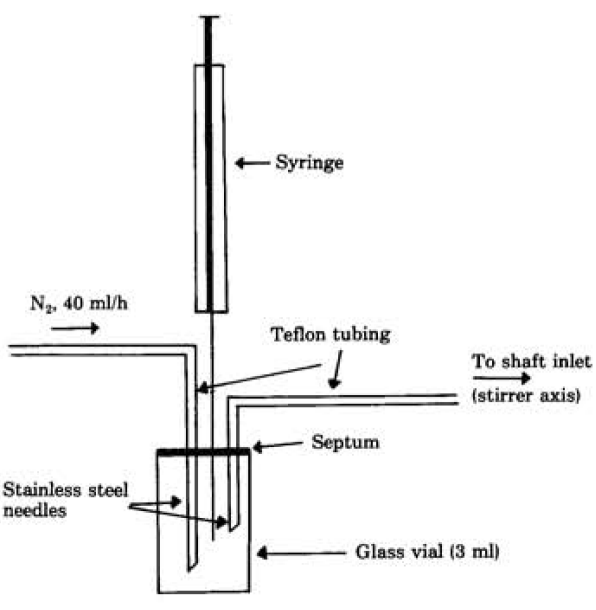

Figure 1. Vapor generation system

were estimated from peak areas. A representative example is shown in Figure 2. The results are given in Table 2. The average deviation between the duplicates was about 5% and the values obtained are of the same magnitude as those few, recent values found in the literature.

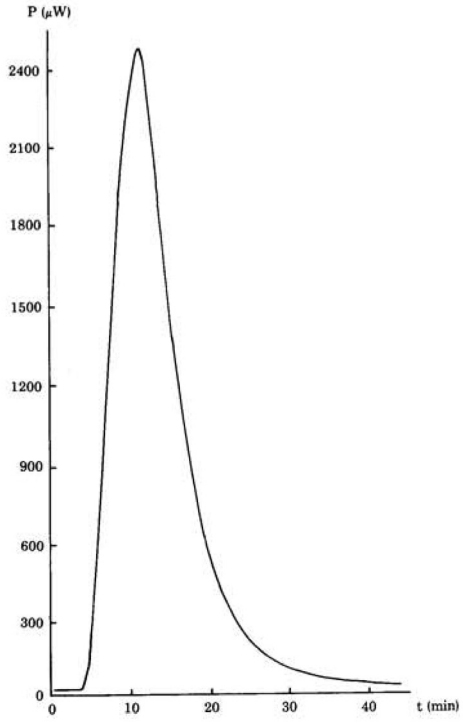

Figure 2. 3μl hexane on 300 mg SKC carbon

CONCLUSIONS

Further design considerations which would provide additional and more refined information include the following:

1) thermostatting the entire vapor generation system to the same temperature as in the calorimeter should allow higher flow rates to be tolerated; 2) the use of diffusion cells in the generation system should provide a more accurate, calculable vapor concentration; and finally 3) it would be preferable to use a smaller diameter adsorption column and to monitor the column outlet to ensure breakthrough does not occur.

Table 1 Characteristics of used carbons

	SKC	Merck
BET Surface Area (m^2/g)	1120	1150
Pore Volume (cm^3/g)	0.59	0.60
pH in Aqueous Solution	9.7	5.7

Table 2 Heats of adsorption (averages)

	Heat of adsorption (kcal/mole)		
	SKC	Merck	Literature[a]
Hexane	14.2	15.1	—
Toluene	12.2	—	—
Ethanol	9.6	12.5	10.5
Propanol	14.5	—	14.5
Acetone	11.0	11.0	—
Water	8.6	11.5	—

[a] Selim M M et al, Carbon 19, 161-5 (1981).