



Activated Carbon Adsorption Isotherms: The Effect of Temperature on Volatile Organic Contaminant Adsorption

Andrew J. Dallas, Ph.D.,* Lefei Ding, Jon Joriman; and Dustin Zastera

Donaldson Co., Inc; Corporate Technology, 9250 W. Bloomington Fwy., Bloomington, MN, 55431

Introduction:

Ambient conditions are typical for many chemical filtration applications; therefore, evaluating activated carbon performance at 25°C in air, or nitrogen, is acceptable for making adsorbent selections. However, in many applications, such as microelectronic devices and hard disk drives, chemical filters are exposed to elevated temperatures. In this work we evaluate the adsorption isotherm of 2,2,4-trimethylpentane (TMP) at 30°C, 50°C, and 75°C on activated carbon.; the objective being to investigate how elevated temperatures influence the capacity of activated carbons for volatile organic contaminants. TMP is chosen as a prototypical organic contaminant test probe for characterizing the adsorption capacity of activated carbon.

Experimental:

The adsorption isotherm of toluene is measured on Carbon C (see our previous reports)^{1,2} over the concentration range of 25-100 ppm using gravimetric methods. Carbon C has a total BET surface area of 1530 m²/gr, a micropore area of 984 m²/gr., and a total pore volume of 0.704 ml/gr. is used. Adsorption isotherms are measured at 30°C, 50°C, and 75°C. The test setup is described in references 1 and 2.

Results and Discussion:

The TMP adsorption isotherms at all three temperatures are given in Figure 1.

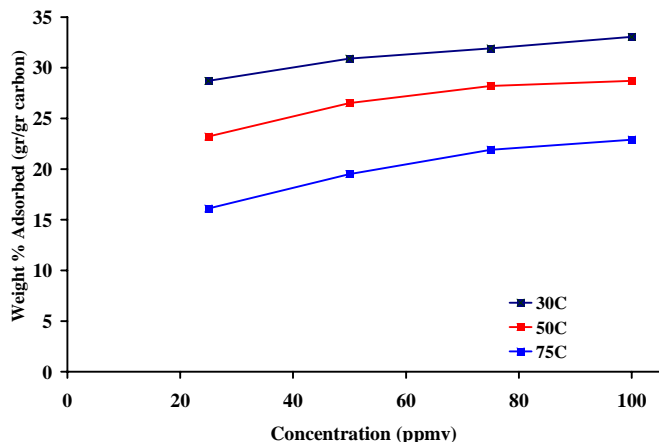


Figure 1: 2,2,4-Trimethylpentane adsorption isotherms at several temperatures.

The effect of temperature on the adsorption capacity is readily seen in Figure 2 and Table 1 which show that a temperature increase of 20°C and 45°C results in approximately a 4.9% and

a 11.0% weight change in the adsorption capacity of Carbon C for TMP. This corresponds to approximately a 0.25% decrease in weight of TMP adsorbed per 1°C increase in temperature.

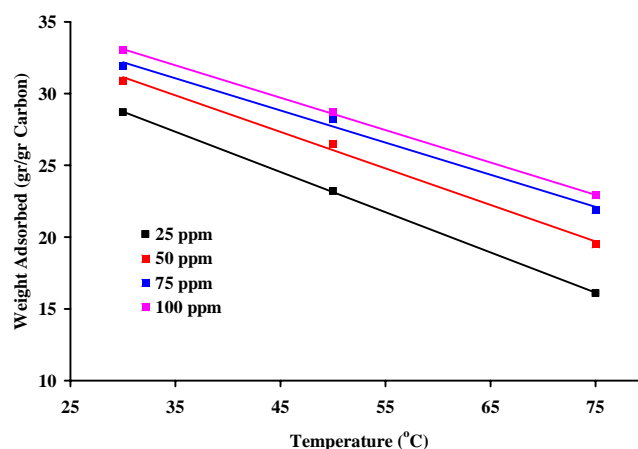


Figure 2: Effect of temperature on adsorption capacity of TMP on Carbon C.

Table 1: Effect of temperature on adsorption capacity of TMP on Carbon C at several concentrations.

Conc. ^a (ppm)	Slope ^b	S.E. ^c	R ² ^d	+20°C ^e	+45°C ^e
25	-0.28	0.003	1.000	-5.60	-12.6
50	-0.254	0.017	0.996	-5.08	-11.4
75	-0.224	0.018	0.993	-4.48	-10.1
100	-0.226	0.004	1.000	-4.52	-10.2
Average =				-4.92	-11.07

a) TMP concentration; b) slope of regression line (wt. %/°C); c) standard error of slope; d) correlation coefficient; e) weight % change with temperature increment.

Summary:

Adsorption isotherms measured at several temperatures were used to evaluate the effect of temperature on the performance of an activated carbon to adsorb a prototypical volatile organic contaminant, 2,2,4-trimethylpentane. The adsorption capacity decreased approximately 5% and 11% by weight for the temperature intervals of 20°C and 45°C, respectively. These values correspond to a weight decrease of approximately 0.25% for each 1°C increase in temperature. Future efforts will be directed at a similar evaluation of other contaminants.

* e-mail: andrewd@mail.donaldson.com; phone #: 952-887-3318; FAX: 952-887-3937

References:

1. A. J. Dallas, et al.; Donaldson Company, Inc., Chemical Filtration Technical Note: CFTN-1-DD, 2003.
2. A. J. Dallas, et al., Donaldson Company, Inc., Chemical Filtration Technical Paper: CFTP-1, 2004.