Different adsorption isotherms of carbon dioxide on raw and impregnated activated carbon

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1. Summary

The improvement in adsorption capacity of activated carbon through impregnation by an ammonia solution was demonstrated in comparison with five raw activated carbon samples. The adsorption data were fitted to standard models and the parameters of the models were determined using various regression techniques.

Keywords: adsorption, isotherm, activated carbon, impregnation, carbon dioxide

2. Extended Abstract

Activated carbon is a highly microporous material with a large surface area and has been employed as a potentially good adsorbent due to its high selectivity for CO_2 adsorption [1, 2].

In this study, the equilibrium adsorption of CO_2 on five raw activated carbon samples A, B, C, D, E and one modified activated carbon sample F has been measured volumetrically using a vacuum adsorption system at sub-atmospheric pressures ranging from 300 to 1000(mbar) and ambient temperature. The results are presented in Figure 1.

Samples A, B, C, D, and E were five commercially activated carbons customarily used for gas adsorption. Sample F was sample A impregnated with a 25% ammonia solution for one month and then dried at 308-318 K for 12h. As can be seen from Figure 1, the impregnated activated carbon sample F showed significant improvement in the amount of adsorbed CO_2 compared to the raw activated carbon sample.

The adsorption data were fitted to the Freundlich model by linear regression and to the Sips and Toth models by a trial and error regression method. These models are used as standard models with a wide range of application [3].

The Sips model was found to give the best fit for the adsorption of carbon dioxide on raw activated carbon samples A, B, C while the Toth model was found to give the best fit for the raw activated carbon sample D. The Freundlich model was found to be the best model for the adsorption of carbon dioxide on raw and modified activated carbon samples E and F. The estimated values of the parameters best fitting the isotherm models are presented in Table 1.

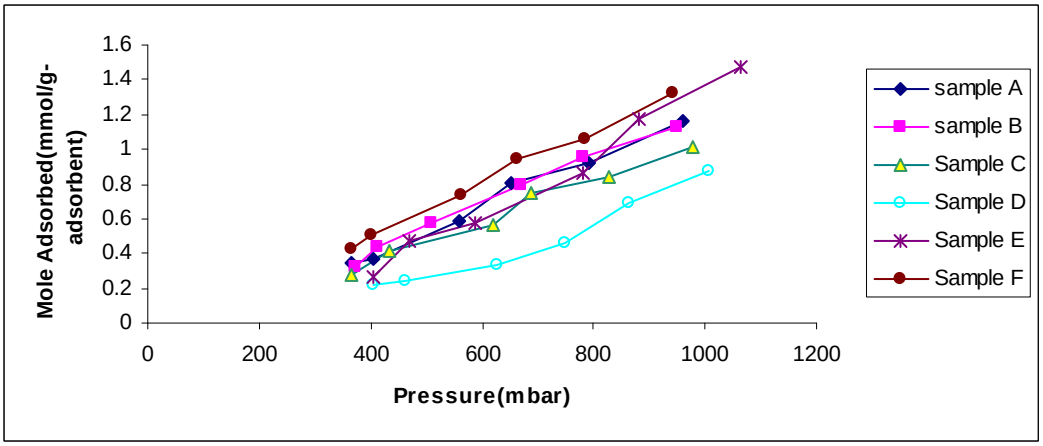

Figure 1: Experimental adsorption isotherm for CO_2 on six different adsorbents.

Table 1: Constants of the best fitting isotherm models for the adsorption of carbon dioxide on six activated carbon samples

Activated Carbon	Best Fitting Model	Equation of the model	Constants of The Best Fitting Model
A	Sips	$c_\mu = c_s \cdot \frac{(bp)^{1/n}}{1+(bp)^{1/n}}$	C_s=1.7531 b=0.00137 n=0.45251
B	Sips		C_s=1.5634 b=0.00156 n=0.42437
C	Sips		C_s=2.0270 b=0.00102 n=0.55905
D	Toth	$C_\mu = C_s \frac{b_p}{\left[1+(bp)^t\right]^{1/t}}$	C_s=0.20849 b=0.00134 t=1.2591
E	Freundlich	$c_\mu = kp^{1/n}$	K=2.405e-5 n=0.63156
F	Freundlich		K=0.00056 n=0.88074

References

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