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Adsorption of Phenyl Thiourea by Active Carbons

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The adsorption of phenyl thiourea has been studied on different activated carbons. The adsorption isotherms show a steep rise in adsorption at lower concentrations and reaching a limiting value at higher concentrations. The maximum amount of phenyl thiourea adsorbed shows a linear relationship with the surface area.

INTRODUCTION

The activated carbons with a low degree of activation and with a greater number of narrow micropores have a greater adsorption capacity than with wider micropores having larger micropore volume[1]. The presence of dissolved organic matter in surface water decreases the effectiveness of granular activated carbon filters in the treatment of drinking water[2]. Heilshorn[3] studied the removal of volatile organic compounds from contaminated water on activated carbon system for water purification. The present communication deals with the study the adsorption isotherms of a slightly basic compound (phenyl thiourea) containing a thio group in its chemical structure.

EXPERIMENTAL

Four samples of commercially available activated carbon varying in their specific surface areas and oxygen contents were used. After that, these samples were degassed at 700° and 1000°C in a carefully calibrated silica tube furnace. Then active carbon was treated with nitric acid[4, 5] oxidized with aqueous hydrogen peroxide by the method already reported in literature[6, 7]. For oxidation with ammonium persulphate carbon sample (5 g) was mixed with 250 mL of saturated solution of ammonium persulphate in sulphuric acid and the suspension shaken for 24 h. The carbon was filtered, washed with hot distilled water till free of sulphate ions and dried in an oven. The sample was then stored in a glass bottle flushed with nitrogen.

0.5 g of each carbon was placed in contact with aqueous solutions of phenyl thiorea for 24 h with occasional shaking. The change in concentration was determined by Hitachi 330 double beam spectrophotometer using a wavelength of 250 nm.

RESULTS AND DISCUSSION

The adsorption isotherms of phenyl thiourea from aqueous solution of concentration varying between 5 and 50 ppm on four different activated carbons

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are present in Fig. 1. It is seen that the isotherms generally show a steep rise in adsorption at lower concentrations reaching a limiting value at higher concentrations. The adsorption is different on different carbons, being generally smaller in the case of BG-series carbons (carbon A, B and C) and appreciably higher in case of the L-series carbon (carbon E).

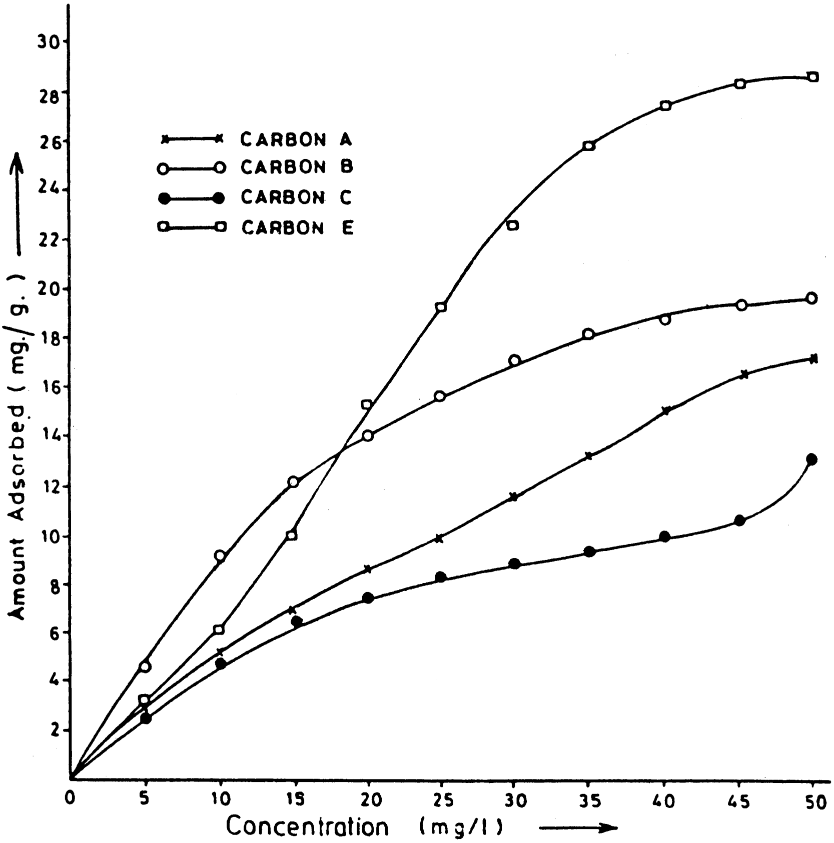

Fig. 1 Adsorption isotherms of phenyl thiourea on different active carbons.

The adsorption of phenyl thiourea is in the order:

Carbon E > Carbon A > Carbon B > Carbon C.

This is incidentally the same order as the surface area of these carbons. A relationship between the surface area and the amount of phenyl thiourea adsorbed at 50 ppm concentration is shown in Fig. 2. It is seen that a fairly good straight line can be drawn at all the points indicating that the adsorption is determined by the surface area of the carbon.

As phenyl thiourea is only slightly basic in character (pH of its solution is slightly greater than 7), and as it contains a benzene ring in its chemical structure,

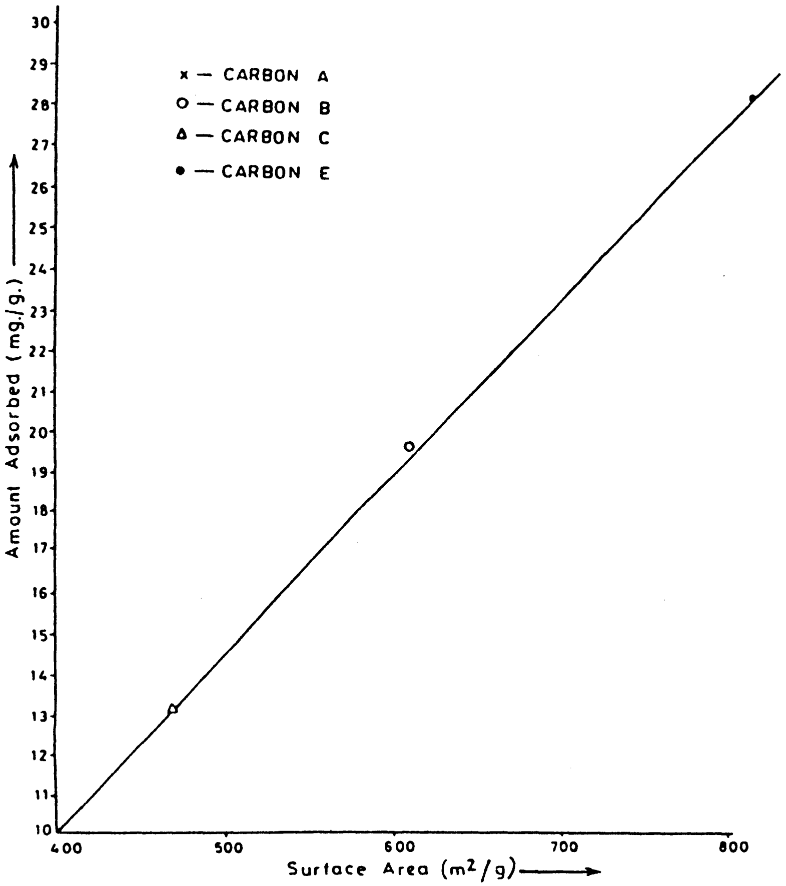

Fig. 2 Relationship between surface area and the amount of phenyl thiourea adsorbed at 50 ppm concentration.

it was thought of interest to examine the influence of carbon oxygen surface compounds on its adsorption.

The adsorption isotherms on four samples of carbons after degassing them at 700° and 1000°C are plotted in Fig. 3. It is seen that the adsorption of phenyl thiourea inceases considerably on the BG-series of carbons (carbon A, B and C) but remains more or less unchanged in the L-series carbon (Carbon E). Furthermore, the increase in adsorption is considerable when the carbons are degassed at 700°C while there is only a slight additional increase in adsopriton when the carbon is degassed at 1000°C. In other words, the adsorption isotherms for 700° and 1000°C outgassed samples are very close to each other while they are sufficiently higher compared to the original carbon samples. It is apparent, therefore, that the adsorption of phenyl thioureas is also determined by the presence of surface oxygen compounds which are evolved as CO. These surface

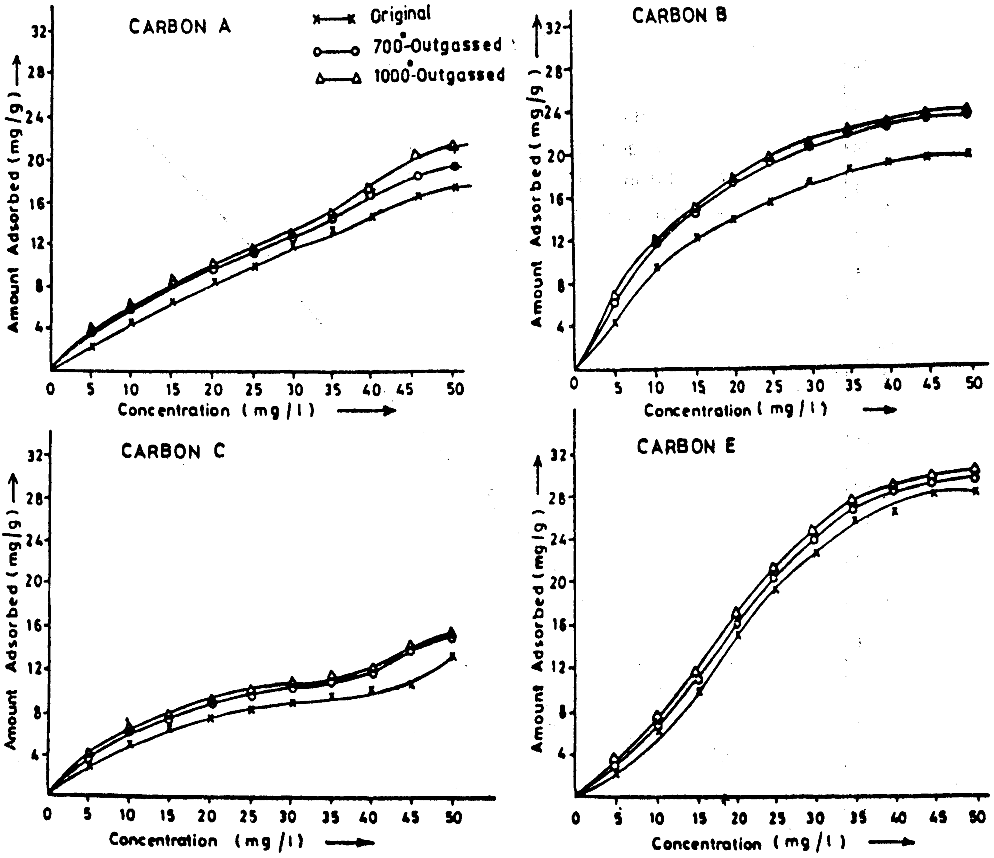

Fig. 3 Adsorption isotherms of phenyl thiourea on active carbon A, B, C and E before and after evacuation.

compounds are well known to be quinonic oxygen groups and thus the adsorption of phenyl thiourea involves the same π-bond interaction of the benzene ring with the carbonyl carbon atom.

In order to check this possibility further four of the activated carbons, were oxidised with hydrogen peroxide, nitric acid and ammonium persulphate and the adsorption isotherms determined again. These isotherms are presented in Fig. 4. It is interesting to note that the adsorption of phenyl thiourea now decreases considerably in all the oxidised carbons. Furthermore, the decrease in adsorption is maximum in the case of the treatment with nitric acid which is one of the severest oxidative treatments. This treatment also results in the formation of maximum amount of surface compounds which are evolved as carbon dioxide on degassing. This shows that as in the case of the adsorption of phenols, the adsorption of phenyl thiourea is suppressed by the presence of the CO_2 evolving surface compounds. In the case of the L-series carbons the oxidation does not involve the fixation of appreciable amounts of oxygen and, therefore, the adsorption of phenyl thiourea does not decrease appreciably.

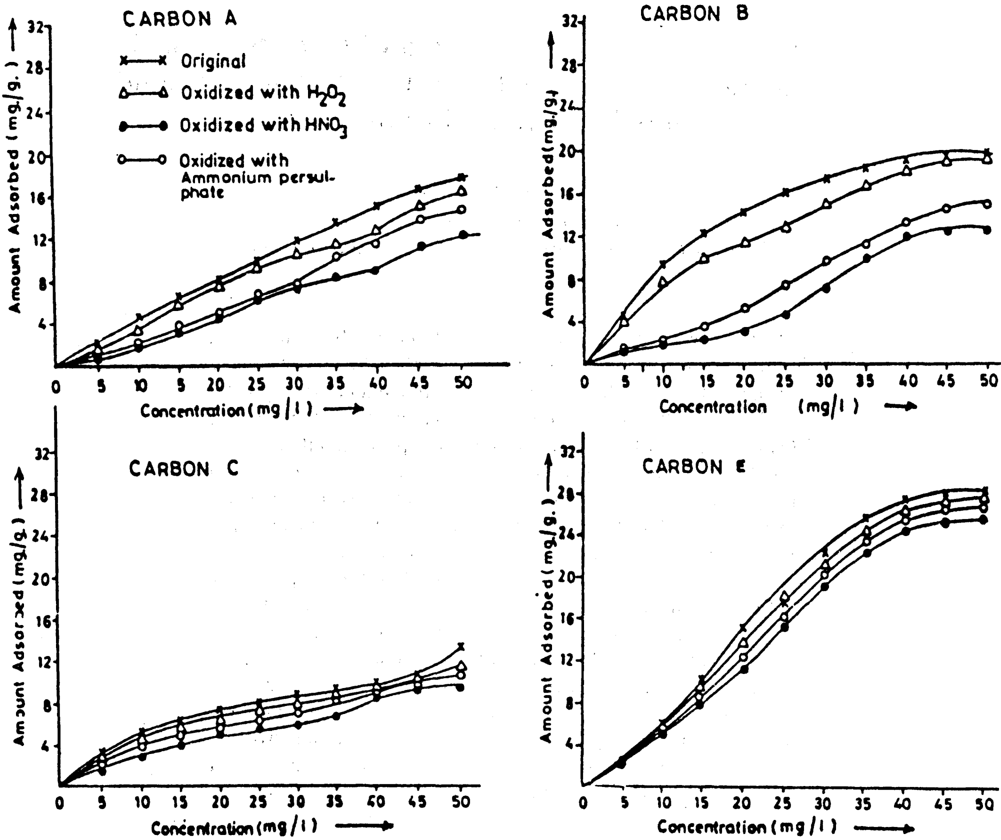

Fig. 4 Adsorption isotherms of phenyl thiourea on active carbon A, B, C, and E before and after oxidation.

Since certain pesticides contain thio groups and these pesticides can be leached into ground water, phenyl thiourea may be used as an organic compound for adsorption studies. It is highly toxic and emits toxic fumes in contact with acid.

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