ADSORPTION OF PHENOL BY ACTIVATED CARBONS

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INTRODUCTION

Adsorption on activated carbons is used as one of the methods for removing impurities from liquid solutions and gaseous mixtures. The adsorbents used are generally in the form of powder or granular carbons. Recently, another form of carbon, i.e. fibrous activated carbons, have become commercially available. These carbons are prepared by the carbonisation of phenol fibre precursor Kynol, cellulose fibre and pitch precursors followed by their activation in carbon dioxide gas or steam. Such carbons have been found to be more beneficial as they can be converted into different textile forms and non-woven carbon materials that offer low resistance to the flow of gases and liquid solutions. These properties are likely to increase the adsorption rate and permit much greater flexibility and simplification in the design of adsorbent systems used for pollution control. It was, therefore, thought of interest to study the adsorption of phenol on fibrous activated carbons associated with different carbon-oxygen surface structures.

EXPERIMENTAL

The samples of activated carbon fibre used in this study were obtained from Ashland Petroleum Company, U.S.A. The granular activated carbons were well known Norit varieties. The carbons were modified by outgassing in vacuum at 400, 650 and 900°C and by surface oxidation with aqueous solution of H_2O_2, $(NH_4)_2S_2O_8$ and HNO_3 (50%).

The adsorption of phenol from aqueous solution was studied by contacting 50 mg of the carbon sample with 50 ml of phenol solutions of different concentrations. The decrease in the concentration of phenol solution was measured by a UV spectrophotometer.

RESULTS AND DISCUSSION

The adsorption isotherms of phenol at 35°C on two samples, marked as A and B, of fibrous activated carbon and two samples

of granular activated carbons, marked as C & D, are presented in Fig.1. The isotherms are of type 1 of the BET classification. All the four carbons adsorb appreciable amount of phenol; the amount varying between 1.75 to 2.25 m mol/g for fibrous activated carbons and between 2.25 to 2.50 m mol/g for granular activated carbons. The extent of adsorption increases with surface area but there is no direct relationship between the two. It appears that the chemical nature of the surface also influences the adsorption of phenol on activated carbons.

In order to examine the influence of the chemisorbed oxygen on the amount of phenol adsorption, the carbon surfaces were modified by outgassing at 400, 650 and 900°C and also by oxidation with aqueous solutions of H_2O_2 and $(NH_4)_2S_2O_8$ and HNO_3 (50%). These treatments do not result in any appreciable variation in the surface area of these carbons. It is interesting to note that the adsorption of phenol decreases on oxidation but increases on outgassing the carbon samples. The decrease in adsorption on oxidation is more when the carbon is oxidised with HNO_3 or $(NH_4)_2S_2O_8$ than when oxidised with H_2O_2 solution. Since nitric acid is a more stronger oxidising agent and can, therefore, result in the chemisorption of larger amounts of oxygen, the larger decrease in adsorption of phenol in the case of oxidation with nitric acid can be attributed to the inhibiting effect of the chemisorbed oxygen.

A careful examination of the isotherms on the outgassed samples shows that the magnitude of phenol uptake is more on 650°-outgassed samples. It appears that the nature of oxygen complexes on the carbon surface also plays an important role in the adsorption of phenol. The 650°C-outgassed carbon sample is completely free of all acidic surface oxygen groups while 900°C-outgassed samples is almost completely free of any associated oxygen. The original and 450°C-outgassed samples, on the other hand, are associated with both acidic and non-acidic carbon - oxygen surface groups.

The maximum adsorption in the case of 650°-outgassed carbon fibre sample indicates that the presence of acidic surface groups supresses the adsorption of phenol while the emergence of CO evolving structures enhance it. A slight decrease in the amount of phenol adsorbed on 900°C-outgassed carbons is due to the absence of almost entire amount of the combined oxygen.

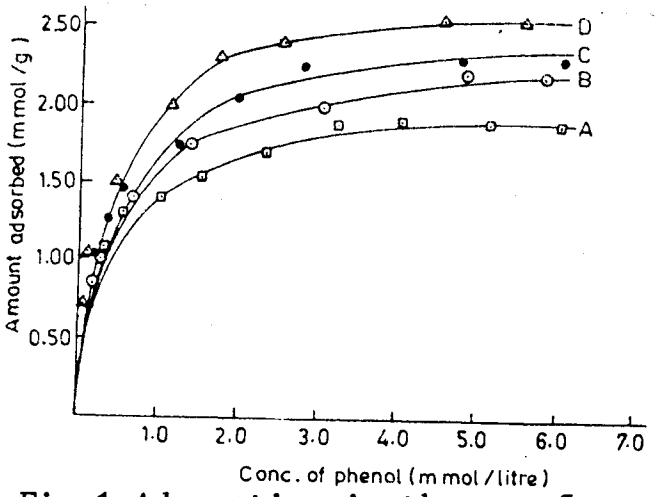

Fig.1 Adsorption isotherms of phenol on activated carbons