Are the activated carbon fibers poor adsorbents for proteins?

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The adsorption experiments of several proteins such as gelatin, egg albumin and hemoglobin have been performed onto the surfaces of activated carbon fibers and their adsorption capacities have been compared with the traditional adsorbents.

The application of activated carbon fibers (ACF) for the removal of organic micropollutants has been accepted as one of the most possible options in water purification\(^1,2\). A larger surface area and the presence of well organised micropores on the surface have made the ACF as a unique adsorbent over the common activated carbons (AC) and other metal oxides. Although a great deal of work has been done on the adsorption of low molecular weight organics onto the ACF, very few research papers deal with the behaviour of proteins at the liquid-ACF interface.

In fact, the adsorption of proteins at a solid-liquid interface is a phenomenon of vital significance in a great number of technological, industrial and biological processes such as in biological membranes, cell processes and recognition processes, thrombus formation, immobilized enzymes etc\(^3-5\). In the present work the adsorbing efficiency of the ACF has been studied for the three proteins viz. gelatin, egg albumin and hemoglobin.

Experimental

The proteins used as adsorbates were gelatin, egg albumin and hemoglobin and obtained from the Loba Chemie, India. The ACF, gifted by Dr Ranjan Kothari, National Physical Laboratory, New Delhi, India, was a microporous cloth of pore size less than 20 nm and surface area 1500-2000 m\(^2\) g\(^{-1}\). The other adsorbents used were also of AR grade. The adsorption experiments performed at pH 12.7 were carried out in a similar way as reported in our other communications\(^6,7\).

Results and discussion

The results of the adsorption experiments are shown in Table I which clearly imply that in comparison to the ACF about 13 to 113 per cent more adsorption of proteins occurs with other adsorbents while in the case of small sized ions a greater adsorption capacity is exhibited by the ACF. The results confirm the poor adsorbing capacity of the ACF

![Fig. 1—Pore structure of a common and ACF adsorbent](image-url)

Table 1—Data showing the adsorption capacities of various adsorbents

<table>
<thead>
<tr>
<th>Adsorbent</th>
<th>Gelatin (mg g(^{-1}))</th>
<th>Egg-albumin (mg g(^{-1}))</th>
<th>Hemoglobin (mg g(^{-1}))</th>
<th>Cu(^{2+}) (mg g(^{-1}))</th>
<th>Ni(^{2+}) (mg g(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alumina</td>
<td>46.8</td>
<td>80.5</td>
<td>113.0</td>
<td>45.3</td>
<td>58.0</td>
</tr>
<tr>
<td>Silica</td>
<td>38.4</td>
<td>72.0</td>
<td>78.3</td>
<td>40.6</td>
<td>48.6</td>
</tr>
<tr>
<td>Bentonite</td>
<td>69.2</td>
<td>96.4</td>
<td>147.9</td>
<td>25.0</td>
<td>32.0</td>
</tr>
<tr>
<td>Fuller earth</td>
<td>54.8</td>
<td>82.6</td>
<td>95.7</td>
<td>18.8</td>
<td>52.4</td>
</tr>
<tr>
<td>ACF</td>
<td>31.2</td>
<td>64.4</td>
<td>69.6</td>
<td>90.6</td>
<td>87.0</td>
</tr>
</tbody>
</table>
which may be explained on the basis of the surface morphology of the adsorbents. In Fig.1 is shown the pore structures of a common adsorbent and the ACF\textsuperscript{8}. It is clear from Fig.1 that whereas a common adsorbent has micro and macropores on its surface, the ACF has only micropores situated on the outside of the fibers. This implies that because of the much larger dimensions of the protein molecules the micropores will not be much accessible to the molecules and, therefore, the adsorption will be less. However, the small sized ions will easily approach the active sites and get adsorbed in greater amounts.

We believe that with the proper choice of pore sizes adsorption may be advantageous not only in separation of mixtures of small and large sized molecules but also in fractionation of synthetic macromolecules where monodispersity is needed for several end use.

References