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THE SORPTION OF HYDROGEN BY PLATINISED CHARCOAL.

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It was shown in previous papers from this laboratory[1] that the introduction of small quantities of platinum into ash-free activated charcoal strongly influences its behaviour in the presence of aqueous solutions of electrolytes. While unplatinised charcoal which has adsorbed oxygen keeps its oxygen charge in a hydrogen atmosphere, the oxygen layer is removed by hydrogen from charcoal which has been promoted by platinum and the positive oxygen charcoal is changed into a negative hydrogen charcoal. In the presence of insufficient quantities of platinum transitional states are observed, but adsorption measurements show us that a transitional state of this kind is not due to a simultaneous existence of positive and negative spots on the charcoal surface, the charge being always the same at all points of the charcoal surface for a given content of platinum and gradually changing from positive

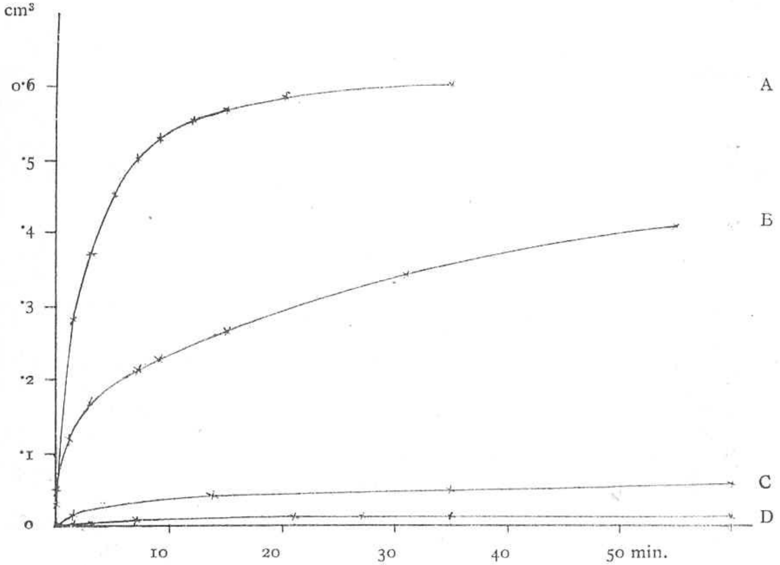

FIG. 1.—Adsorption of hydrogen by charcoal at different temperatures.
A, 500°; B, 310°; C, 200°; D, 25°.

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[1] B. Bruns and A. Frumkin, *Z. physik. Chem.*, **141A**, 141, 1929; A. Frumkin, S. Lewina and O. Zarubina, *ibid.*, **155**, 71, 1931; A. Frumkin, *Koll. Z.*, **51**, 123, 1930.

to negative as the platinum amount is increased. It appeared therefore worth while to investigate whether the process of interaction between a bare, oxygen-free charcoal surface and hydrogen is catalysed by platinum and whether, in this case too, the properties of the whole surface of charcoal are changed when a small part of it is covered with platinum. The experiments performed up to now are insufficient to give an answer to the second question, but they show conclusively that platinum catalyses the hydrogen sorption by charcoal.

Experimental.

The charcoal used was activated ash-free sugar charcoal; the mode of preparation and of introducing the platinum was the same as described by Bruns and Frumkin.[1] The charcoal was outgassed for twenty-seven hours at 900° C. under vacuum before being brought into contact with the hydrogen.

Fig. 1 shows the kinetics of the hydrogen adsorption at different temperatures in c.c. of hydrogen (at 760 mm. and 0° C.) per 10 gr. of charcoal. The initial pressure was 1·5 mm., the volume of the apparatus about 250 c.c. and the actual amount of the charcoal used in the experiments 5 gr.

Fig. 2 shows the influence of the platinum (0·2 per cent. Pt). The initial pressure was 0·23 mm. in the experiments at 25° C. and 1·5 mm. in those at 310° C.

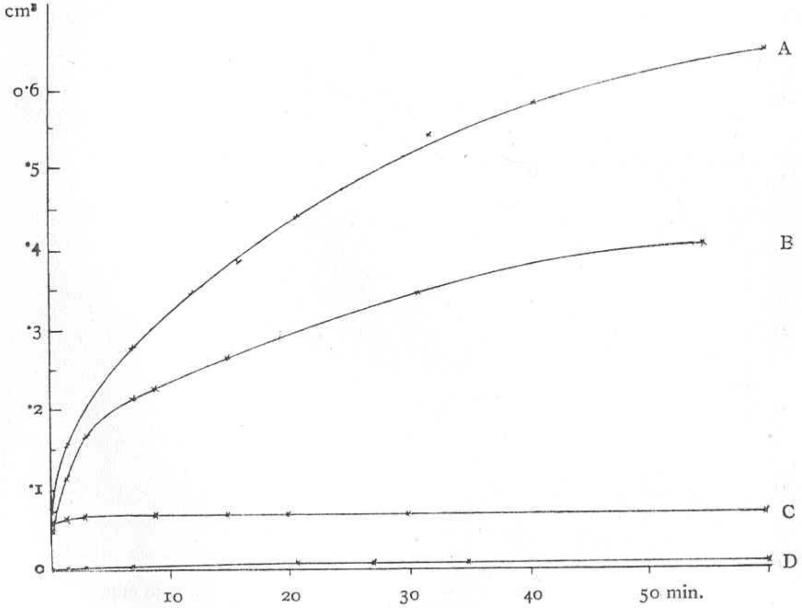

FIG. 2.—Influence of platinum on the adsorption of hydrogen by charcoal.
Curve A. 310°, 0·2 % Pt. Curve B. 310°, 0 % Pt.
" C. 25°, 0·2 % Pt. " D. 25°, 0 % Pt.

Discussion.

The adsorption of hydrogen on charcoal is an example of "activated" adsorption, as has already been shown by Kingman.[2] This is confirmed by our measurements on activated sugar charcoal, the amount adsorbed rising strongly with increasing temperature. Schuster[3] observed a similar increase of the low pressure hydrogen adsorption with rising temperature but the kinetical behaviour of Schuster's charcoal was different, as the equilibrium pressure was practically reached in one minute. This was a technical charcoal, which contained iron and traces of copper. It is not quite certain whether hydrogen adsorption by charcoal is completely reversible, since on outgassing the charcoal which has adsorbed hydrogen the formation of small amounts of a dark deposit on the walls of the reaction vessel is always observed; this is probably due to the decomposition of some hydrocarbons. As shown by the curves of Fig. 2, platinum enhances the activity of charcoal towards hydrogen, although the effect is rather smaller as we have expected on the basis of experiments mentioned at the beginning of this note. We hope to continue this work on different lines and to compare the influence of the platinum on the hydrogen adsorption with its effect on the activity of charcoal in various hydrogenation processes.

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[2] *Nature,* **127**, 742, 1931; **128**, 272, 1931.
[3] *Z. physik. Chem.,* **14B**, 253, 1931.

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