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Fig. 1.

Figure 1: Fig. 1.

Abstract

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ON THE RELATIONSHIP BETWEEN THE MECHANICAL PROPERTIES OF GRAINS OF SULFOCATIONITES AND THE ESTABLISHMENT OF PSEUDOEQUILIBRIUM STATES DURING SORPTION OF ORGANIC IONS ON THEM

(Presented by Academician V. A. Kargin, 27 IX 1962)

Earlier we reported on results obtained in a study of the exchange sorption of methylene blue ions on KU-2 sulfocationites with 2 and 6% divinylbenzene (DVB) ([1]). It was shown that, upon sorption of the dye on the H-form of a cationite with 2% DVB, at all the temperatures investigated in the interval from 40 to 75°, equilibrium states are established in the exchange systems, and the amounts of dye ions absorbed by the cationite are equal to the exchange capacity of the resin. At the same time, the diffusion coefficients of methylene blue ions in the exchanger phase, as the content of dye ions in the initial cationite increases, decrease only slightly (approximately by a factor of two when the equivalent fraction of dye ions in the initial resin increases from 0 to 0.8). A similar picture is observed in the sorption of the dye on the cationite with 6% DVB at 75°. However, at lower temperatures (40 and 60°) it is not possible to replace all the hydrogen ions in the cationite by dye ions, and pseudoequilibrium states are established in the exchange systems. In this case, the diffusion coefficients of the organic ions in the exchanger decrease by one to two orders of magnitude as the equivalent fraction of dye ions in the initial cationite increases from 0 to 0.8.

Fig. 1. Relationship between the load on grains of KU-2 sulfocationites with 2% *(a)* and 6% *(b)* DVB and deformation at 20° at different equivalent contents of methylene blue ions in the exchangers. The numbers beside the curves indicate the equivalent content of dye ions in the exchanger. Each curve was drawn from the average data of measurements on 4–6 cationite grains.

Fig. 2

Figure 2: Fig. 2

Fig. 3

Figure 3: Fig. 3

Since the size of the sorbed ion and the distances between the links of the ionite structure are comparable in magnitude, it is obvious that the mobility of the links of the ionite structure must have a great influence on the course of the sorption process. To test this supposition, we determined the elastic properties of grains of KU-2 cationites with 2 and 6% DVB at different temperatures in the range from 20 to 75° and compared the data obtained with the permeability of these cationites with respect to dye ions. We determined the elasticity of the grains on cationites with different equivalent contents of methylene blue ions, from 0 (H-form) to 1 (complete replacement in the cationite of hydrogen ions by dye ions).

As the criterion of the elastic properties of cationite grains we used the coefficient of elasticity, representing the magnitude of grain deformation under a load of 1 g. We calculated the coefficient of elasticity from

dependence between the load on an ionite bead, in grams, and the decrease in the diameter of the ionite bead in the direction of the action of the load, in percent. We measured the elasticity of cationite beads in a thermostated apparatus constructed by us, operating on the principle of a lever balance. At small deformations (approximately up to 10%) the magnitude of the deformation is proportional to the load applied to the bead (Fig. 1). In all experiments the deformation was reversible. For measurement, beads with identical diameters ($±$10%) were selected.

Fig. 2. Change in the elasticity of beads of the sulfo cationites KU-2 with 2% (a) and 6% (b) DVB as a function of the content, in the exchangers, of methylene-blue ions at different temperatures. The numbers near the curves indicate the equivalent content of dye ions in the exchanger.

Fig. 3. Relation between the elasticity of beads of the sulfo cationites KU-2 with 2 and 6% DVB and the diffusion coefficients of methylene-blue ions in these exchangers ($\overline{D}$). Temperature: 1 –60°, 2 –75°, and 3 –40°. For 100% elasticity at all temperatures, the elasticity of the H-form beads of the exchangers was taken. The dotted line denotes resin with 2% DVB, and the solid line denotes resin with 6% DVB.

Figure 2 shows the results obtained in determining the elasticity of beads of KU-2 cationites with 2 and 6% DVB at different temperatures and with different contents of dye ions in the exchangers. In this case, the elasticity of beads of the H-forms of the exchangers at 20° was taken as 100%. The numerical values

of the elasticity coefficients of beads of the H-forms of the ionites at 20° are 1.95 for the cationite with 2% DVB and 0.25 for the cationite with 6% DVB. As the equivalent fraction of methylene-blue ions in the ionite increases, the elasticity of the beads decreases, and for the exchanger with 6% DVB to a considerably greater extent. This effect diminishes with increasing temperature and, in the case of the less "cross-linked" ionite, disappears completely at a temperature of 75°.

Figure 3 compares the elasticity of cationite beads containing different amounts of dye ions (data taken from Fig. 2) with the diffusion coefficients of methylene-blue ions in these same cationites (data from communication (1)). From the curves shown in Fig. 3 it is seen that the greater the decrease in the elasticity of the cationite beads as they pass from one form to another, the greater the decrease in the permeability of the cationites with respect to organic ions diffusing in them. In those cases where pseudo-equilibrium states are established in the exchange systems (cationite with 6% DVB, temperatures 40 and 60°), a significant decrease in the elasticity of the cationite beads

as the content of dye ions in it increases, is accompanied by a considerable decrease in the permeability of the cation exchanger with respect to diffusing ions (the diffusion coefficients of dye ions decrease by one to two orders of magnitude).

From the data presented, it may be concluded that, during the sorption of organic ions on sulfonated cation exchangers, the elasticity of the links of the cation-exchanger structure has a major influence on the course of the exchange process. The establishment of pseudo-equilibrium states during the sorption of organic ions on sulfonated cation exchangers is associated with a considerable decrease in the mobility of the links of the exchanger structure as the exchange process proceeds.

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Note: Figure translations are in progress. See original paper for figures.