

The nature of supramolecular structure changes and hydrophilic properties of cellulose in adsorption-desorption processes

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Abstract

A modernized scheme of the structural organization of cellulose, taking into account the peculiarities of its capillary-porous system, is proposed. The paper describes the process of adsorption of water molecules on the hydrophilic walls of porous formations between the structural elements of cellulose. Within the framework of the Brunauer-Emmett-Teller theory, the nature of the interaction of the components of the cellulose-water system is studied using isotherms of adsorption and desorption of water vapor on cellulose. It is established that the process of cellulose moistening is accompanied by an increase in the specific surface and a decrease in the degree of its crystallinity. Within the framework of the modern concepts of the physicochemical chemistry of surface phenomena, the lateral dimensions of the slit-like pores, characteristic of cellulose and its derivatives, are calculated, which are filled with water at the corresponding values of the relative vapor pressures of the adsorbent. In the framework of the theory of surface phenomena, it is postulated that when capillary condensation occurs in narrow pores, a concave fluid meniscus is formed, leading to a decrease in Laplace pressure, which causes enhanced adsorptive diffusion in the area under consideration and, as a result, the transition of unsaturated steam to saturated with the formation of a dew point. It is shown that the adsorption-desorption hysteresis observed in the entire range of relative vapor pressures of the adsorptive, to a large extent, is associated with the appearance of an additional capillary-porous system due to the wedging pressure from the condensing water molecules. This is confirmed by the fact that the calculated values of the monolayer capacity and specific surface area for the desorption isotherm significantly exceed the corresponding values for the adsorption branch. It is found that the proportion of the specific surface belonging to the pore walls of cellulose, in relation to the total specific surface, both during adsorption and during desorption, does not exceed 70%.

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