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AEROGELS BASED ON GELLAN HYDROGELS

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Abstract

This work is devoted to the establishment of the main patterns of intermolecular interactions of gellan in water-salt mixtures, as well as the creation of composite materials based on gellan, the determination of their basic physicochemical characteristics, and the identification of promising aspects of the practical application of the obtained materials for food purposes.

Keywords: gellan, cobalt, swelling time, microscope, airgel, molecules.

Introduction

Aerogels were obtained from hydrogels after removal of the solvent from their volume by freezing. They were porous and loose materials, which, regardless of the concentration of salts of divalent metal salts and the type of cation, were brittle. They break easily when pressed.

The degree of swelling of airgels in distilled water was determined from the change in their volume and mass. It should be noted that the swelling of aerogels was limited. If in dry form they were fragile, then when moistened, they practically retained their integrity. The results are presented in figures 1 and 2 as a dependence of the degree of swelling, calculated by volume and weight, versus time. It can be seen that all aerogels swell to the maximum during the first two hours. With an increase in the time of keeping aerogels in distilled water up to two days, the values of the degree of swelling practically do not change and are comparable to each other. With a longer contact with water, only partial destruction occurs along the edges of the samples. It can be concluded that aerogels are water insoluble materials. The big disadvantage is their fragility.

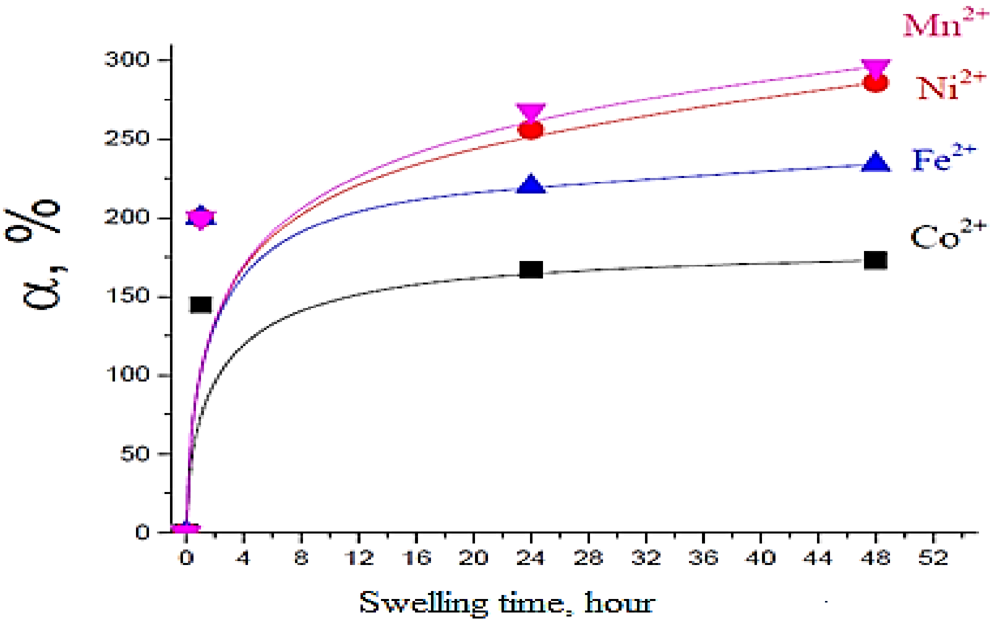

Figure 1. The dependence of the degree of swelling of aerogels in distilled water on time (the degree of swelling is calculated by volume)

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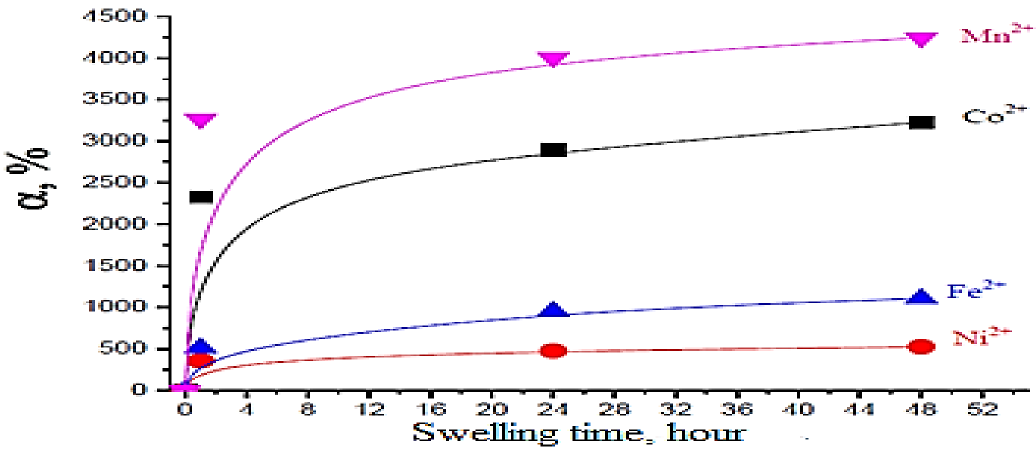

Figure 2. The dependence of the degree of swelling of aerogels in distilled water on time (the degree of swelling is calculated by weight)

The results of calculating the degree of swelling in terms of volume and weight differ from each other by about an order of magnitude. This is due to the fact that aerogels have a porous and loose structure. When swelling in water, the pores are filled with a solvent, which makes the samples heavier and affects the mass when weighing the samples.

When comparing the degree of swelling of airgel samples obtained with different salts of divalent metals, it can be seen that, according to calculations made on the basis of geometric dimensions, they have similar values, but differ in mass. This is due to the structure of aerogels. Figure 3 shows photographs taken with a scanning electron microscope.

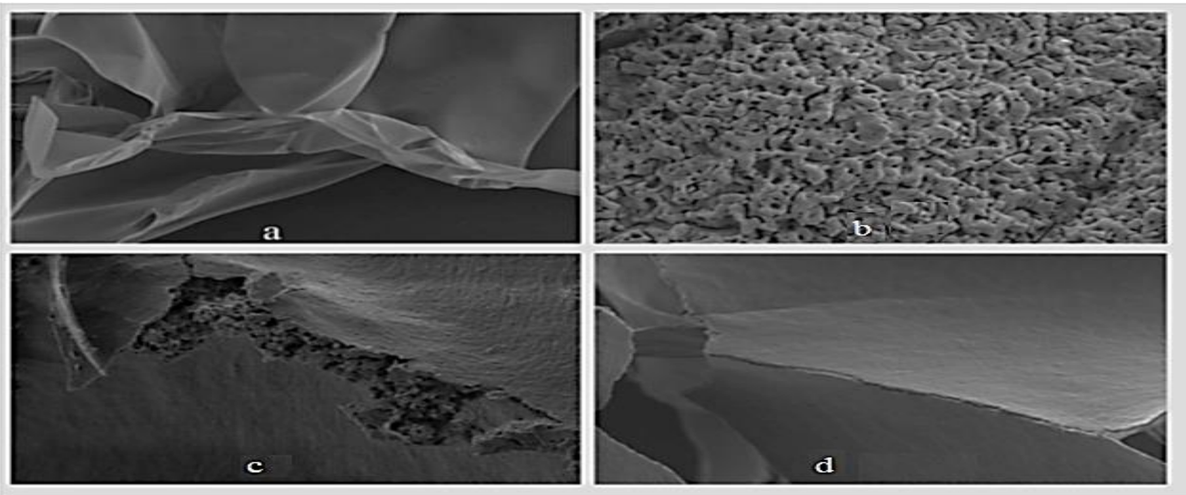

Figure 3. Scanning electron microscope images of airgels. Sample composition: gellan 0.6 wt . %, (a) initial gellan , (b) gellan with 3 wt % nickel cations . % , ; (c) gellan with 3 wt % iron cations; (d) gellan with 3 wt % cobalt cations . %

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It can be seen that the surface morphology of airgels obtained in the presence of various divalent metal salts differs from each other. The airgel obtained from the gellan solution has a film structure. When swelling, its gradual dissolution begins. In the case of airgels obtained with cobalt cations, the surface is layered and smooth, while with nickel and iron cations, it is loose. This affects the degree of swelling. Layered aerogels with cobalt cations swell more strongly (Figure3), since water fills the spaces between the layers to a greater extent.

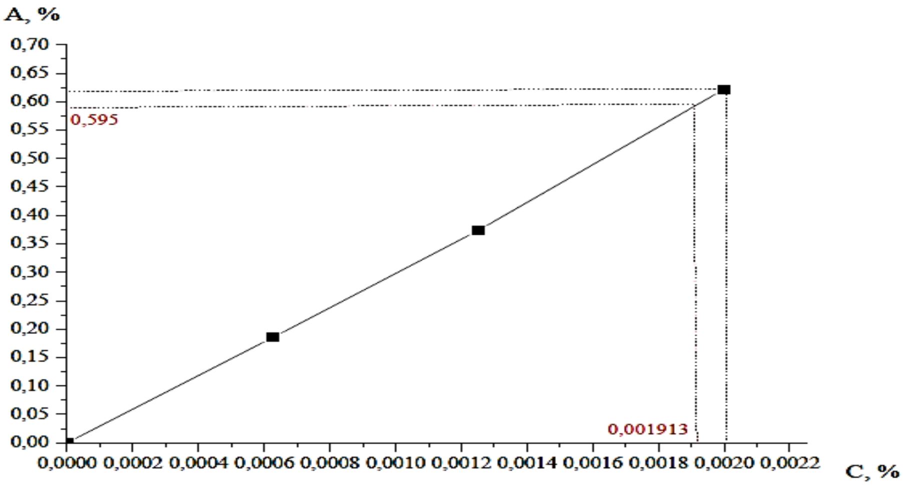

Figure 4. Dependence of optical density on the concentration of methylene blue

For the practical use of aerogels, their adsorption capacity was studied. For this purpose, airgel fragments were immersed in aqueous solutions of methylene blue, and the adsorption value was calculated from the change in the concentration of the dye. Figure 4 shows the calibration curve, which was used to determine the concentration of the dye.

Table 1 - Experimental data on airgel adsorption

Rogels with metal cations	Optical density _ be	Concentrat ion to adsorption _ _ Cdo , %	Concentrat ion after adsorption _ After , %	Mass of the sample and mobr , g	Solution volume ra V, gr	Ravnove sleepy adsorption ia G, y/y
Gellan	0.481	0.00162	0.001533	0.0064	8.0102	0.4756
Ni2+	0.745	0.00239	0.002303	0.0221	8.0201	0.1415
Zn2+	0.495	0.00192	0.001833	0.0044	8.0339	0.146
Co2+	0.706	0.00227	0.002183	0.0172	8.0218	0.1026
Mn2+	0.682	0.00219	0.002103	0.0158	8.0228	0.0964
Fe2+	0.777	0.00249	0.002403	0.0140	8.0012	0.28

The numerical values of the calculated values are given in Table 1 and shown in the diagram shown in Figure 4. It can be seen that the aerogels obtained with nickel cations have the highest adsorption capacity.

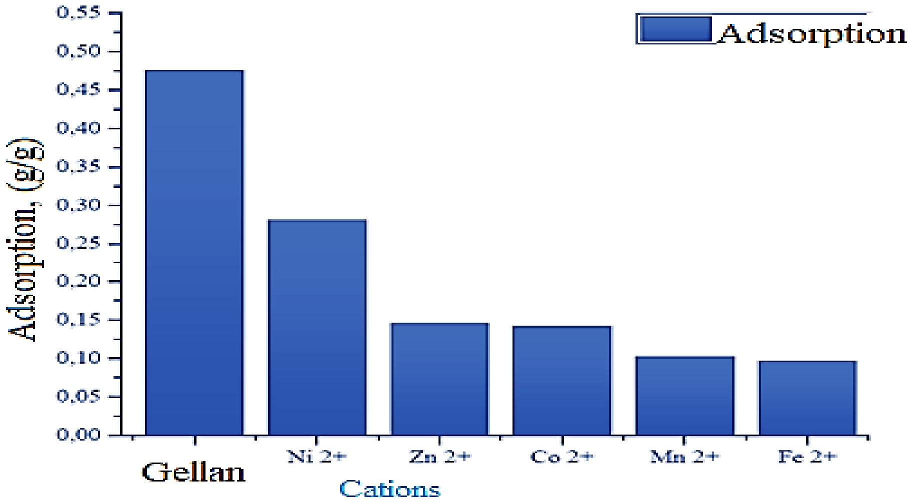

Figure 4. Diagram of dependence of airgel adsorption on metal cations

For aerogels obtained from a gellan solution, the adsorption value is maximum, but such aerogels are water-soluble, which is of no practical interest.

This property, as well as the degree of swelling, depend on the surface morphology. In the case of such aerogels, it is more porous, which contributes to a better retention of dye molecules in the volume.

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