Application of kinetic models to the description of doxorubicin adsorption processes on the surface of nanosized magnetite

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Magnetically sensitive materials based on Fe_3O_4 with predicted parameters and properties are bioavailable and characterized by satisfactory adsorption-desorption indicators. Therefore, the development and optimization of methods for the synthesis of nanoscale materials based on Fe_3O_4 do not lose their relevance. An important stage in predicting the mechanisms of adsorption processes is the modeling of experimental data for assessing the adsorption capacity of the material.

Here we report on the application of kinetic models that were used to describe the adsorption of doxorubicin (DOX) on the surface of nanosized magnetite synthesized by the Elmore reaction. The obtained nanoparticle samples had an average size of 12 nm, S_{sp} = 90 – 110 m^2/g, σ_s = 62.6 ± 2.5 % $Gs \cdot cm^3/g$, and were characterized by absolute single-domain.

The kinetics of DOX adsorption on the surface of nanosized Fe_3O_4 was studied at a concentration of C_0 = 0.0758 mg/ml (m = 0.03 g, V = 5 ml, saline, 3 h in static mode at room temperature). The change in DOX concentration was determined spectrophotometrically (λ = 480 nm). To calculate the adsorption kinetics, mathematical models were used that are used to describe the processes of immobilization of drugs from aqueous solutions by various adsorbents. Data on DOX adsorption kinetics were approximated using pseudo-first-order models (Lagergren model), pseudo-second-order models, which are widely used to analyze the kinetics of single-component adsorption at the adsorbent-adsorbate interface, as well as the Yelovitch and Avrami models, external diffusion models, internal diffusion models of Boyd, Weber-Morris, and Bengham. According to the values of theoretically calculated sorption capacity values, which are as close as possible to the experimental ones and the highest correlation coefficients ($R^2 \geq$ 0.95), preference is given to the pseudo-second-order model, as well as to the Avrami and Bengham internal diffusion models.