Preparation of composite adsorbents based on humic acid and silicon oxide

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The paper presents the results of research on the preparation and study of the physicochemical properties of a composite based on humic acid and silicon oxide.

To obtain humic acid (HA), brown coal from the «Maikuben» deposit was used as a feedstock, pre-crushed to a particle size of less than 0.3 mm and having the following characteristics (wt%): Ad 25.8; Wr 9.3; Vd 46.6; Std 0.71. The yield of free humic acids was 56%.

To obtain the modification of HA / SiO₂ and its carbonized form, the dried sample (HA) is crushed to a powdery state and mechanically mixed with SiO₂ obtained from ash-and-slag waste from «Bogatyr» coal in a ratio of 10/1 (HA / SiO₂). The resulting powder was carbonized in a tube furnace in an argon atmosphere of 800°C for 1 hour at a heating rate of 5°C per minute. The elemental composition of the carbonized composite based on HA/SiO₂ = 1:1 is (wt%): C-27.46, O-31.32, Na-0.07, Mg-0.14, Al-2.2, Si-8.67, S-0.76, Cl-

Figure 1. Results of SEM images (a) and Raman images (b) of a composite based on HA / SiO₂.

, K-8.89, Ca-0.53, Cu-0.69, Fe-8.18. SEM images of the sample are shown in Fig. 1, where one can observe flocculent formations and spherical silicon oxide with sizes ranging from 223.1 nm to 515.8 nm. Raman results are signals with characteristic peaks D and G (1350.08 cm⁻¹ and 1594.5 cm⁻¹). The intensity ratio I_D/I_G is 0.59, which confirms a large number of sample defects. The degree of graphitization (G_f) is 30.88%. The resulting composite material has been tested for the purification of heavy metals under dynamic conditions. As a result of sorption, the resulting composite showed a high degree of purification (%): Zn-100.0, Cd-91.57, Pb-91.66, Cu-100.0, which may be due to the significant ability of HA to form complex and intracomplex (chelate) compounds with heavy metals and high sorption capacity of the composite with silicon oxide nanoparticles.

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