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Adsorption of iron (III) and bismuth (III) ions onto micro- and macroporous glasses

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Porous glasses (PG) belong to the silica containing porous materials (silica content >95%) that are the products of the acidic leaching of phase-separated alkali borosilicate glasses. Due to the conditions applied during the production process (starting composition, sintering temperature, sintering duration, etc.), well-defined properties like pore size (range between 0.3 and 1000 nm), pore volume, or specific surface area can be adjusted. All this makes PG a highly functional material used in sorption, separation and destructive water treatment technologies.

The feasibility of porous glasses prepared from sodium borosilicate glass leached in 3 M HNO3 solution for adsorptive removal of Fe (III) ions from FeCl3 aqueous solution at pH=3 in the concentration range of 10□3 – 10□4 M and removal of Bi (III) ions from the Bi(NO3)3 solution (10-3 – 10-4 M) in 2M H(NO3) was investigated.

A study of the PG's pore morphology is an important problem, because their structure parameters, including the pore inhomogeneities, affect the sorption, capillary, diffusion, adhesive, optical, and other properties. It was revealed that the additional alkaline treatment of MIP glass (specific BET area S0=219 m2/g, volume porosity W = 0.24, average pore radius r = 1.3 nm) resulted in an increase in W, a decrease in S0, and an increase in r values (MAP glass: S0=100 m2/g, W = 0.57, r = 12 nm). Part of MIP glass samples had been subjected to heat treatment at 750 °C (MIP 750) which led to the following structural parameters: S0=57 m2/g, W = 0.16, r = 3.1 nm. The r values obtained from the analysis of SEM images is in good agreement with the values determined by the BET method.

PG samples (40 mg – MIP, 80 mg – MAP, 160 mg – MIP 750) were immersed in 40 sm3 of FeCl3 or Bi(NO3)3 solutions, and the obtained dispersions were stirred for 24 hours. After centrifugation, the Fe (III) or Bi (III) content in the solution before and after adsorption were determined by atomic absorption spectroscopy with inductively coupled plasma (Thermo scientific A A Spectrometer iCE 3000). The present investigation showed that the removal efficiency of Fe (III) decreases with the increase in initial of Fe (III) concentration. Comparison of the adsorption values measured on the MAP PG at different contact times between electrolyte solution and porous glasses shown that in this case the adsorption equilibrium is practically established in half an hour. We also found that the adsorption values grow with increasing pore radius of PG's and that the MAP glasses possess a higher limiting adsorption of Fe (III) ions (3.3×10−11 mol/cm2). This phenomenon can be explained by the absence of overlap of double electric layers and, accordingly, by the larger surface charge of the silica surface of macroporous glass compared to microporous glass. The adsorption values of Bi (III) ions for the studied samples of PG's are of the same order of magnitude and are somewhat higher than that of Fe (III) ions. Note that the obtained values are also consistent with the surface charges of PG's and may be due to the large ionic strength of Bi(NO3)3 solutions. The adsorption data were analyzed using Langmuir and Freundlich isotherms.

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Biography:

In 2018 I graduated from St. Petersburg State University, Institute of Chemistry with a bachelor's degree in chemistry. I am currently continuing my studies in the Master's program. The research results are published in articles in the Colloid Journal and Glass Physics and Chemistry, as well as presented at Russian and international conferences. The present researches are focused around the study of electro surface phenomena in macro- and nanostructured oxide systems.

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