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Co-Adsorption of Pesticides on Surfactant-Modified Adsorbents

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Extended Abstract

The presence of pesticides in drinking water sources is caused mainly by means of agricultural activities and the need to increase world food production which results in river and groundwater pollution, damaged ecosystems, and can negatively affect human health. Adsorption is one of the water treatment processes used for the removal from water. There has been a great deal of interest in the use of surfactant-modified zeolites and zeolite-carbon composites as adsorbents to prevent and remediate environmental contamination by pesticides. The introduction of organic cations through ion exchange reactions has been proposed to improve the adsorptive capacity of zeolites and zeolite-carbon composites for organic compounds, including hydrophobic pesticides.

The present work aims to investigate the adsorption behaviour of our pesticides: 2-(2,4-dichlorophenoxy)acetic acid (2,4-D) and 2-(4-chloro-2-methylphenoxy)acetic acid (MCPA), 6-chloro-2-N,4-N-diethyl-1,3,5-triazine-2,4-diamine (simazine) and methyl N-(1H-benzimidazol-2-yl)carbamate (carbendazim) on fly-ash-based zeolites and zeolite-carbon composites. The adsorbents were modified using a cationic surfactant (hexadecyltrimethylammonium bromide (HDTMA-Br)) and a non-ionic surfactant (t-octylphenoxypolyethoxyethanol (Triton X-100, TX100)). Adsorption experiments involved the influence of initial concentration and co-adsorption of pesticides. Moreover, the stability of the adsorbents during the adsorption experiments was also examined. The concentration of each pesticide in water samples was analyzed using high-performance liquid chromatography with a UV detector.

The results of the experiment clearly show that an increase in the concentration in the solution resulted in an increase in the adsorption capacity. At an initial concentration of 4 mg/L, the adsorption effectiveness of simazine and carbendazim is much higher than for any other concentration. For 2,4-D and MCPA adsorption efficiency increases more gradually. Simultaneous adsorption of MCPA, carbendazim, and simazine revealed that the adsorption of carbendazim and simazine from single-component solutions is higher than that of multicomponent solutions for all tested adsorbents. MCPA exhibit higher adsorption on HDTMA-modified adsorbents when adsorbed from a single-component solution, however, for unmodified adsorbents and those modified with Triton X-100 adsorption is more efficient if carbendazim and simazine are also present - adsorption on samples X-FA-T and X-C-T increases by more than 30%. Peaks in the XRD patterns of adsorbents before and after adsorption that correspond to the zeolite and their positions reveal no significant changes between samples before and after the adsorption of pesticides. This suggests that the adsorbents did not disintegrate during 24 hours of stirring with pesticide solution at pH 5, and in selected adsorption conditions, the adsorbents are stable.

In summary, carbendazim and simazine are the most effectively absorbed in unmodified zeolite-carbon composite, but HDTMA-modified adsorbents are more effective for the adsorption of MCPA and 2,4-D at higher initial concentrations. Moreover, MCPA seems to be more effectively adsorbed on X-FA-T and X-C-T if other pesticides are present in the solution. Experiments also revealed that adsorbents are stable under the conditions of the selected experiments; however, further experiments are required to fully understand the potential of unmodified and modified zeolite-carbon composites as adsorbents of pesticides.

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