Adsorption of Fe(III), Cr(III), Cd(II), Pb(II) and Cu(II) on a new nanostructured hybrid material containing aluminium

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The adsorption properties of a novel nanostructured di-urethanesil hybrid material modified by aluminium towards Cu(II), Fe(III), Cr(III), Cd(II) and Pb(II) ions was studied. The material was prepared for the first time via new chemical precursor sol-gel method using tetraethylorthosilicate, trimethylsilyl isocyanate and aluminium sec-butoxide. From the XRD, SEM, FTIR, AFM and TEM results, the structure of the derived xerogel can be described as amorphous porous material built from Si-O-Al and Si-CH_3 repeated structural units covalently bonded onto the siloxane network by urethane (-NHC(=O)-) bridges to form a di-urethanesil backbone. The characterization of porous and texture parameters of the alumosilica oxycarbonitride material was carried out by low-temperature adsorption of nitrogen. The nitrogen adsorption isotherms were analyzed to evaluate the following parameters: specific surface area; total pore volume and average pore diameter.

Adsorption of Cu(II), Fe(III), Cr(III), Cd(II) and Pb(II) ions on this material was investigated using single- and multi-component aqueous solutions with different concentrations and acidity by means of the batch method. The adsorption was significantly affected by the pH value. Equilibrium modelling data were fitted to linear Langmuir, Freundlich and Dubinin-Radushkevich models. In the present study, best fitting was observed by the Langmuir model, which showed correlation coefficients of greater than 0.992 for all ions studied. Thus we proved that Langmuir isotherm most adequately described the adsorption processes of the investigated ions.

The removal of all investigated ions from multi-component aqueous solutions was significantly affected by the presence of competitive ions. For that reason the single-component adsorption for Pb, Cu and Cr was also studied. The maximum adsorption capacities for multi- and single-component adsorption were calculated. Highest adsorption capacity was achieved for Pb(II) ions. Therefore it is supposed, that the novel nanostructured hybrid material can be used for lead removal from aqueous solutions.