Geophysical Research Abstracts
Vol. 16, EGU2014-16564-1, 2014
EGU General Assembly 2014

Organic hydrogels as potential sorbent materials for water purification

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Hydrogels are three-dimensional, hydrophilic, polymeric networks capable to adsorb large amounts of water or biological fluids. The networks are composed of homopolymers or copolymers and are insoluble due to the presence of chemical or physical cross-links. Depending on the nature of the structural units, swelling or shrinking of these gels can be activated by several external stimuli, such as solvent, heat, pH, electric stimuli. As a consequence, these materials are attractive for several applications in a variety of fields: drug delivery, muscle mimetic soft linear actuators, hosts of nanoparticles and semiconductors, regenerative medicine etc. Of special interest is the application of hydrogels for water purification, since they can effectively adsorb several water soluble pollutants such as metal ions, inorganic or organic anions, organic dyestaff, etc.
In the present work, anionic hydrogels bearing negatively charged –COO- groups were prepared and investigated. These are based on the anionic monomer sodium acrylate (ANa) and the nonionic one N,N-dimethylacrylamide (DMAM). A series of copolymeric hydrogels (P(DMAM-co-ANax) were synthesized. The molar content x of ANa units (expressing the molar charged content of the hydrogel) varies from 0 (nonionic poly(N,N-dimethylacrylamide), PDMAM, hydrogel) up to 1 (fully charged poly(sodium acrylate), PANa, hydrogel). The hydrogels were used to extract organic or inorganic solutes from water. Cationic and anionic model dyes, as well as multivalent inorganic ions, have been studied. It is found that cationic dyes are strongly adsorbed and retained by the hydrogels, while adsorbance of anionic dyes was negligible. Both maximum adsorption and equilibrium binding constant depend on the chemical structure of the dye, the presence of functional chemical groups and the hydrophobic-hydrophilic balance. In the case of metal cations, adsorption depends mostly on the charge of the cation. In addition, crucial factors controlling the adsorption efficiency is the charge content of the hydrogel x, as well as the pH of the aqueous solution, since acrylic acid is a weak acid.

ACKNOWLEDGMENTS. This research has been co-financed by the European Union (European Social Fund – ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) - Research Funding Program: Archimedes III. Investing in knowledge society through the European Social Fund; research project Archimedes III: “Synthesis and characterization of novel nanostructured materials and study of their use as water purification systems”.