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Book of Abstracts



L-10 | Influence of lignin-derived natural organic compounds on the separation of organic contaminants onto zeolites from water matrices

Chenet Tatiana¹, Sarti Elena², Stevanin Claudia¹, Costa Valentina¹, Cescon Mirco², Martucci Annalisa³, Pasti Luisa¹

¹ Department of Environmental and Prevention Sciences – University of Ferrara, Ferrara, Italy

² Department of Chemical, Pharmaceutical and Agricultural Sciences – University of Ferrara, Ferrara, Italy

³ Department of Physics and Earth Sciences, University of Ferrara, Ferrara, Italy

Natural organic matter (NOM), a complex mixture of organic compounds, is commonly found in surface and groundwaters. Humic substances represent 40-80% of the NOM content and they are found in freshwater typically in a concentration range 1-25 mg/L [1]. Among this class of compounds, humic acids form a complex mixture of natural substances derived from the biodegradation of lignin; they are characterised by carboxyl and phenolic groups, and they are resistant to further degradation. p-Hydroxybenzaldehyde (p-HBA) and caffeic acid (CA) are monomers of humic acids that are commonly found in natural waters.

Toluene is a hydrocarbon belonging to the BTEX class (Benzene, Toluene, Ethylbenzene, Xylene) which is frequently detected in all environmental compartments due to its wide use as solvent, antiknock agent in gasoline, and for the production of benzene.

High-silica zeolites have already been proven to be efficient eco-friendly adsorbents for the removal of several organic contaminants from aqueous solutions [2]. To evaluate the possible use of these materials in water remediation applications, the adsorption of toluene in water matrices containing naturally found organic molecules, p-HBA and CA, was explored. Besides their natural occurrence, p-HBA and CA were chosen due to their molecular dimensions which are comparable with those of the contaminant selected and smaller than the pore size of zeolite.

In this work, zeolite ZSM-5, with MFI framework type topology and Si/Al ratio of 280, was chosen to investigate the adsorption of the selected organic compounds. Regarding the adsorption of the humic acids monomers, the systems ZSM-5 – p-HBA and ZSM-5 - CA were considered. Adsorption isotherms were determined at different pH values to establish the effect of this parameter onto the saturation capacity of the adsorbent materials.

Regarding the adsorption of the contaminant (TOL) from the aqueous matrix containing the natural humic acids monomers (p-HBA or CA), it resulted that the natural compounds do not show competitive behaviour: the adsorption of TOL was slightly affected by the presence of the ligninderived substances [3]. The higher selectivity of ZSM-5 for TOL with respect to p-HBA and CA was also confirmed from structural investigation of the selected zeolite loaded with single component solution of TOL and p-HBA or CA, and from a binary mixture containing both the contaminant and the humic acids monomer (i.e., TOL and p-HBA, or TOL and CA). Strong similarities between the X-ray powder patterns after adsorption of the mixture and after only TOL adsorption, indicate that the zeolite adsorb preferentially and selectively toluene, also in the presence of the natural compounds. These findings confirm the high selectivity of zeolites for the removal of organic contaminants from waters in presence of natural components.

[1] Uyguner Demirel, C.; Bekbolet, M.; Swietlik, J. Control of Disinfection By-Products in Drinking Water Systems, January 2007, 253-277.

[2] Sarti, E.; Chenet, T.; Pasti, L.; Cavazzini, A.; Rodeghero, E.; Martucci, A. Minerals 2017, 7(2), 22.

[3] Chenet, T., Sarti, E., Costa, V., Cavazzini, A., Rodeghero, E., Beltrami, G., Felletti, S., Pasti, L., Martucci, A. J. Environ. Chem. Eng. 2020, 8(5), 104229.