DIRECTED MODIFICATION OF HUMIC SUBSTANCES AS A GATEWAY TO THEIR USE IN REMEDIATION TECHNOLOGIES

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Humic substances (HS) are multifunctional natural compounds that consist of the highly substituted aromatic core and bound to it carbohydrate-peptidic periphery . Due to a wide variety of functions, HS can bind both heavy metals and organic ecotoxicants. The ecotoxicants bound into humic complexes become non-toxic that causes a net reduction in toxicity in polluted environments. In addition, HS are shown to play an important role in redox transformations of both organic xenobiotics, heavy metals, and radionuclides. Despite the above properties, HS have not been widely used in remediation technologies. The fundamental reason is the extreme structural heterogeneity, which translates into chemical properties that are difficult to control. In this context of importance is a direct relationship between detoxifying and binding properties of HS in relation to heavy metals and polycyclic aromatic hydrocarbons (PAH) established in our previous works. These findings allowed us to elaborate a novel approach of directed chemical modification for acquiring humic derivatives of the desired reactive properties.

To realize the proposed approach, three types of modification were applied to the humic materials from peat and coal: sulfonation, hydroxylation, and acidic hydrolysis. Sulfonation was to produce derivatives that form much more soluble complexes with transition metals, hydroxylation was to increase the binding, detoxifying and redox-mediating properties of HS toward heavy metals and radionuclides; acidic hydrolysis was to obtain the hydrophobe derivatives of an increased binding affinity for organic ecotoxicants. For sulfonated derivatives, as expected, a substantial increase in solubility of Fe and Hg complexes along with a decrease in their stability constants was found. The detoxifying ability of sulfonated derivatives decreased in relation to Cu, but did not change toward Hg. For the hydroxylated derivatives, higher detoxifying ability toward Cu and Hg was determined. Of particular interest is the faster kinetics of Pu(V/VI) reduction detected for the hydroxylated derivatives compared to the initial humic material. For the hydrolyzed derivatives, the higher binding affinity for pyrene was found. The consistency of the above changes in properties of the humic derivatives with the changes in their structure allows us to conclude on the feasibility of the proposed approach - to use chemical modification for preparing humic materials of the desired properties. This opens a way to much broader application of humic materials in remediation technologies.

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