OP 1.2

Bioremediation of Selenium containing waters: Importance of Selenium speciation analysis

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The importance of selenium in environmental research is related to the fact that it shows only a marginal line between the nutritious optimum (as an essential element) and toxic effects upon exposure. The environmental fate of selenium compounds varies greatly dependent on its speciation. A huge variety of both anthropogenic and geogenic aqueous waste streams call for an efficient low-tech cleanup solution. Compared to adsorptive or precipitative techniques, the bioreduction of selenate to elemental selenium is a promising, as combining a separation and a detoxification step.

Anaerobic granular sludge previously tested towards selenium bioreduction [1, 2] was used to inoculate two continuous Upstream Anaerobic Sludge Blanket (UASB) Reactors with a working volume of 0.46 L, operated at a superficial upflow velocity of 1 m h-1 and a hydraulic retention time of 6 h. The reactors were operated under methanogenic and sulfate reducing conditions using lactate as carbon source at an organic loading rate of 5 g COD L-1 d-1. Selenate was feed at a concentration of 10 µM.

It was shown that most selenate was indeed converted to elemental selenium [3], but still the removal efficiency for dissolved selenium was lower in comparison with selenate removal. During bioreduction of selenate not only elemental selenium can be formed, but also different other selenium species that might show an even higher toxicity [4]. Consequently selenium was analyzed species specifically in gas phase (SPME-GC-MS), liquid phase (Ion-Chromatography) and solid phase (differential XRD and µ-XANES). Dimethylselenide and Dimethyldiselenide, two toxic substances, were contributing to these dissolved species, as they were detected using SPME-GC-MS. The contribution of the latter species would not have been revealed by standard methods for selenium analysis [5], clearly underlining the importance of species-specific selenium analysis.

[1] V. Astratinei, E.D. van Hullebusch and P.N.L. Lens, J. Environ. Qual. 35, 1873–1883 (2006).
[2] M. Lenz, A. Gmerek and P.N.L. Lens, Intern. J. Environ. Anal. Chem. 86, 615-627 (2006).
[3] E.D. Van Hullenbusch, F. Farges, M. Lenz, P. Lens, G.E. Brown, Jr. (2007). AIP Conference Proceedings 882, 229 – 231.
[4] E.L. Amweg, D.L. Stuart, and D.P. Weston. 2002. Aquat. Toxicol. 63:13–25.
[5] A.D. Eaton, L.S. Clesceri, A.E. Greenberg, Standard methods for the examination of water and wastewater, APHA, Washington, 1995.