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Distillery sludge used to treat radioactive sites

Mining uranium ore leaves sites contaminated with toxic, radioactive material. According to a new study, contaminated sites can be treated with sludge from the treatment of distillery wastewater in bioreactors. The study demonstrates an efficient method for decontamination of groundwater based on bacteria in sludge that naturally convert uranium into an insoluble form that can be more easily removed.

Uranium is radioactive and toxic to animals and humans, accumulating in and causing damage to the kidneys. In the US, the safe limit or maximum contaminant level (MCL) for uranium in drinking water, established by the Environmental Protection Agency, is 0.30µg/L[1]. Different regulations for uranium in drinking and bottled water exist across the EU. The European Food Safety Authority concluded in a 2009 study that most people in Europe would never be exposed to anything approaching the World Health Organization's Tolerable Daily Intake of 0.6µg per kilogram of body weight. However, where there is a high concentration of uranium in drinking water, the limit may be exceeded locally. Contamination of groundwater near to mine tailing sites is one such case.

Bioremediation options for groundwater contaminated with uranium include applying bacteria that can transform uranium from a soluble to an insoluble form. It is then possible to extract the uranium as a black solid. The researchers used bacteria in sludge from a wastewater treatment bioreactor for a sugar beet distillery in the Netherlands. Unlike previous studies, they used the raw sludge rather than a concentrated solution of bacteria, and mixed it into sand.

They fed water containing soluble uranium (VI) into columns filled with the sand/sludge mixture. The transformation of soluble uranium (VI) into insoluble uranium (IV) is a process called 'reduction', which requires other chemicals that supply electrons to drive it. Ethanol has previously been shown to act as a suitable electron donor, so the researchers tried adding ethanol to one of the columns. However, they found that as the biomass in the sludge decayed, it released chemicals that could drive the transformation without any need for ethanol. In fact, they say there is no benefit in adding ethanol over the long term.

The sand columns were monitored for just over a year, with the sand/sludge mixture capable of converting uranium (VI) to the insoluble form at over 99% efficiency. After seven months, the concentration of uranium was consistently below the MCL level. Most, almost two thirds, of the insoluble uranium (IV) produced was then extracted.

Besides the second column containing the additional ethanol, the researchers used a third column to test the effect of nitrates on the efficiency of uranium removal. This is relevant to uranium contamination in the field because some sites are also contaminated with nitrates. They found that nitrates formed nitrites, which then inhibited the action of the bacteria in reducing uranium (VI). They therefore recommend that contaminated sites are pre-treated for nitrates where there is co-contamination.

1. EPA. (2011). Radionuclides in Drinking Water. United States Environmental Protection Agency. [Online]. Available: http://www.epa.gov/ogwdw/radionuclides/index.html

Source: Tapia-Rodriguez, A. Tordable-Martinez, V., Sun, W., Field, J. A., Sierra-Alvarez, R. (2011). Uranium bioremediation in continuously fed upflow sand columns inoculated with anaerobic granules. *Biotechnology & Bioengineering*. 108: 2583-2591.

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