TECHBRIEF

METAL-LOADED BASIC IMMOBILIZED AMINE SORBENTS FOR THE REMOVAL OF METAL CONTAMINANTS FROM WASTEWATER

OPPORTUNITY:

NETL's basic immobilized amine sorbents (BIAS) have previously been shown effective at removing heavy metals and radioactive ions from aqueous sources. Chelating the amines with metals such as iron or copper significantly increases the heavy metal capture affinity of the sorbents, up to 50% over the non-metal chelated amines. In this invention, the metal-chelated polyamine is chemically tethered to a solid silica support (SiO_2) via a crosslinker. The sorbents resist leaching by H_2O in an aqueous stream containing heavy oxyanion-based (and other) metals and demonstrate stability over a pH range of 5-14. Cationic heavy metals are captured by the amine functional groups (-NH_2, -NH, -N) from the polymeric network while oxyanionic metal species bind readily to the metal loaded sites. This technology is available for licensing and/or further collaborative research from the U.S. Department of Energy's National Energy Technology Laboratory.

CHALLENGE:

Heavy metals are common in industrial wastewater streams such as those associated with flue gas desulfurization (FGD), acid mine drainage, hydraulic fracturing, and nuclear fission. As heavy metals pose health and environmental hazards, there is a critical need to remediate them, i.e., safely and efficiently remove them from the aqueous sources. The U.S. Resource Conservation and Recovery Act (RCRA) gave the U.S. Environmental Protection Agency the authority to establish and enforce regulatory policies and toxicity limits arsenic (As), cadmium (Cd), chromium (Cr), lead (Pb), mercury (Hg), selenium (Se), and other metals. Many of these metals present a distinct challenge for capture because they are most commonly present in the polyatomic oxy-anion form. Sources for most of these contaminant metals result from the treatment of fossil fuel-derived, post-combustion flue gas with aqueous-based technologies. The well-known and widespread contamination of RCRA metals in drinking water and other terrestrial water sources either through natural processes or resulting from human activity, demands remediation.

Capture of contaminants from water flowing through sorbent.

OVERVIEW:

NETL researchers have discovered a method for using a metal-chelated polyamine that is chemically tethered to a solid silica support via a crosslinker. These sorbents can be used to capture heavy metals from aqueous sources. The covalent and H_2O-stable sorbents resist leaching by H_2O in an aqueous stream containing heavy oxyanion-based metals with stability of a pH range of 5-14. This stable metal loaded immobilized amine sorbent captured 100 percent of target metals from solutions at concentrations of 23 ppm as single components and 75 ppm total as multicomponent mixtures

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ADVANTAGES:

- Fast and easy preparation procedure.
- Novel combinations of polyamines and metals with monomer cross-linkers immobilized on silica.
- Structurally stable.
- Capture a variety of toxic heavy metals with higher capacity compared to non-metaled sorbents.
- Low cost, scalable, and robust materials.
- High affinity towards toxic oxyanionic forms of heavy metals while maintaining affinity towards toxic cationic metals.
- Simple introduction of multiple types of metal binding sites.
- High commercial potential given outlook for industries generating heavy metal-contaminated water.

APPLICATIONS:

- Capture of As, Cr, Cd, and Se, some of which have radioactive isotopes, found in many coal waste streams and industrial effluents.
- Removal of heavy metal contaminants from flowing or stagnant aqueous systems, including industrial effluent, ponds, rivers, lakes, seawater, and groundwater.
- Other industrial processes which could generate heavy metal contaminated water including steel manufacturing, flue gas desulfurization, petroleum refining, and hydraulic fracturing.

PATENT STATUS:

U.S. Patent Pending (provisional patent application)

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