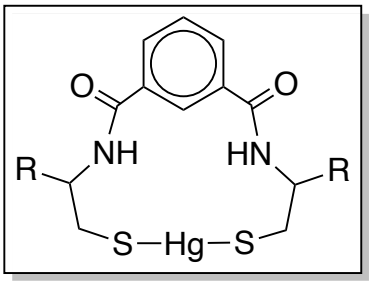
The "B9" Class of Synthetic Dithiols for the Removal of Soft Heavy Metals and As(III) from Water

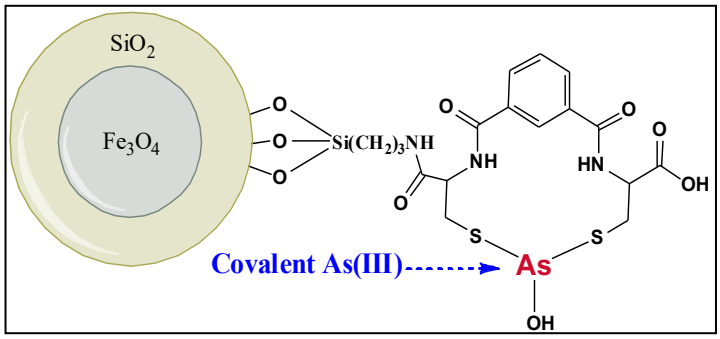
David Atwood, Department of Chemistry, University of Kentucky, Lexington, KY

Abstract



As(III), Hg(II), and several other divalent heavy metals can be completed removed from water using the synthetic dithiol, N,N'-bis(2-mercaptoethyl)isophthalamide, now commonly known as "B9" (with R = H in the first figure). B9 is unique among thiol compounds in that it has no odor and does not form disulfide (-S-S-) bonds, which would make it inactive towards metal capture. For example, aqueous concentrations of As(III), Hg(II), and Pb(II) in the ppm and high ppb range can be reduced to low ppb levels by precipitation as B9-As(OH), $[B9\text{-}Hg]_n$, and $[B9\text{-}Pb]_n$. The metal compounds are amorphous and oligomeric in the solid state, which partially explains the extreme insolubility of the B9 compounds. The B9-Hg precipitate is impervious to degradation over a wide pH range and oxidizing conditions. This has made B9 of utility in applications such as Hg(II) removal from gold mining solutions and Pb(II) precipitation from lead battery recycling effluent. Through the formation of covalent M-S bonds on the surfaces of heavy metal containing minerals, B9 can also prevent acid mine drainage.

To better address water filtration applications, a derivative of B9, called "AB9", was synthesized (with R = COOH in the second figure) and attached to a magnetic nanoparticle coated with silica resulting in the composite material, AB9@MNP. The composite completely removes arsenite from water at low flow rates, and an appreciable fraction of arsenite at flow rates used by home water filters. The arsenic-containing composite can be magnetically separated from water using hand-held magnets. This presentation will provide details on the fundamental structure and bonding of B9 and AB9 metal and metalloid compounds along with background information on aqueous environmental contaminants.



Biography

After graduation from the University of Alabama in Tuscaloosa, David moved to Austin, Texas, to attend graduate school at the University of Texas. In the spring of 1992, he graduated with his Ph.D. degree in Inorganic Chemistry with a dissertation focused the use of molecular precursors to electronic materials such as gallium nitride. In 1993 he became an Assistant Professor in the Chemistry Department at North Dakota State University (NDSU) as part of a new Center for Main Group Chemistry. In 1998 David Atwood joined the Chemistry Department at the University of Kentucky as an Associate Professor and several years later was promoted to Full Professor. His research addresses fundamental and applied aspects of the main-group elements. This includes work on chelated group 13 compounds, molecular routes to metal oxide materials, and the design and use of ligands to remediate and mitigate contaminant elements in water.

Speaker Contact while traveling (phone or email): cell: 859-333-2407; email: datwood@uky.edu