Mercury Removal

Developer: Metcalf & Eddy, Inc.
Contract Number: DE-AC21-97MC33139
Crosscutting Area: ESP

Mixed Waste FOCUS AREA

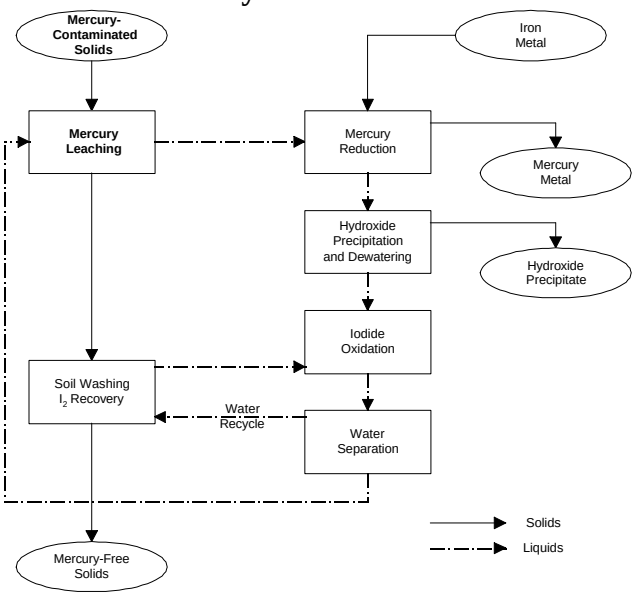
Problem:

The Department of Energy (DOE) used large quantities of mercury in lithium isotope enrichment processes and other defense-related activities. These activities have resulted in the generation of a significant volume of mercury-contaminated waste. Much of this waste is characterized as mixed waste; that is, it also contains radioactive materials. Currently this mercury-contaminated mixed waste is being stockpiled. It cannot be disposed of as low-level radioactive waste because it contains mercury. It cannot be disposed of as a hazardous waste because it contains radioactive material. An efficient, cost-effective method from extracting the mercury from this waste is therefore required.

Solution:

Technology invented by General Electric Company and currently being commercialized by Metcalf & Eddy under the name GEMEP[SM] has been identified as a promising means for effective treatment of mercury-contaminated mixed wastes. The extractant, aqueous potassium iodide plus iodine, has been shown in bench-scale tests to be effective in removing mercury from surrogate soils as well as other wastes. A variety of forms of mercury, including elemental mercury, mercuric oxide, mercuric sulfide, and organo-mercury compounds, were removed from a wide range of materials such as soils, sediments, sludges, plastics, glass, concrete and brick. Work at Oak Ridge National Laboratory has demonstrated efficiencies of 97% to 99% for removal of mercury and its compounds from sediments and glass. Because the extractant is neither acidic nor basic, indigenous metals such as iron are not removed from the solids by the process. Additional development efforts are being conducted to demonstrate the technology's promise for selective removal of mercury from mercury-contaminated mixed wastes.

Mercury Removal Process



Benefits:

The GEMEP[SM] technology is potentially applicable to the wide range of solid mixed waste containing mercury that is currently stockpiled by DOE, such as crushed lamps and building debris, and to contaminated soils and sediments. The benefits of the technology are:

- Selective removal of mercury from mixed waste streams, leaving behind radionuclides and indigenous metals such as iron
- Ability to remove all chemical forms of mercury, including metallic mercury (Hg), inorganic mercuric compounds (e.g., HgO), and organo-mercury compounds (e.g., CH_3HgCl)

▸Applicability to a broad range of media, including soil, sludge, glass, sediments, concrete, and brick

▸Lower risk for fugitive emissions than competing thermal treatment methods, because mercury is not volatilized but is extracted at moderate temperatures

Technology:

The GEMEP^{SM} technology combines the oxidant iodine (I_2) with the complex-forming agent iodide (I^-) in a leaching solution that is able to extract a variety of mercury-containing species from soils, sediments, glass wastes, and other materials. This is a closed-loop process that contains and recycles the extraction components. The process treats mercury-contaminated media and produces mercury-free media, elemental mercury, and a metal precipitate consisting primarily of iron hydroxides.

Mercury Extraction: Mercury-contaminated media is subjected to an aqueous extraction with potassium iodide and iodine (KI/I_2) under controlled pH and temperature. Mercury in its various forms is oxidized by the I_2 to the 2+ oxidation state, which is then believed to form soluble complexes of the form HgI_4^{2-} by complexation with the I^- present in the extraction medium. After sufficient reaction time to solubilize the mercury, the treated media is dewatered, rinsed to remove residual extraction reagent and dissolved mercury, and backfilled or disposed of. The extracted mercury remains in the aqueous phase and serves as the feed stream for the mercury reduction and removal step, along with the water generated from rinsing the treated media.

Mercury Reduction and Removal: The aqueous stream from the extraction step is reacted with finely divided elemental iron to reduce the mercury to its elemental form. The metallic mercury produced in this step is recovered and isolated for off-site recycle. The remaining aqueous phase, containing dissolved ferrous iron and extraction reagent, is treated by pH adjustment to precipitate the iron as ferric hydroxide. After dewatering, the precipitate can be combined with the treated solids from the extraction step for disposal, or it can be managed separately. The aqueous phase remaining after precipitation and dewatering is the feed stream for the reagent regeneration and recycle step.

Reagent Regeneration and Recycle: The spent extraction reagent is regenerated through a combination of pH adjustment and chemical oxidation. The regenerated extraction reagent is recycled to the mercury extraction step.

Contacts:

This project is being conducted by Metcalf & Eddy, the commercial developer of the GEMEP^{SM} technology. For information on this project, the contractor contact is:

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