Innovative Chromium Remediation Technologies

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Chromium plating operations typically produce hexavalent chromium waste. Historic facility operations and management practices at many plating facilities has resulted in soil and groundwater contamination. Federal and State regulations require the investigation and subsequent cleanup of contaminated soil and groundwater to protect human health and the environment. Innovative cleanup methods have been developed to minimize site disturbance, decrease costs and/or the decrease time required to complete cleanup. Some of the innovative methods for the cleanup of hexavalent chromium in soil and groundwater include electrokinetic restoration, constructed wetlands, stabilization/solidification, and reductant injection.

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Introduction

Chromium plating operations typically produce hexavalent chromium waste. Historic facility operations and management practices at many plating facilities has resulted in soil and groundwater contamination. Federal and State regulations require the investigation and subsequent cleanup of contaminated soil and groundwater to protect human health and the environment.

For years contaminated soil was excavated and disposed of at a licensed landfill facility. Contaminated groundwater was typically extracted and treated by a batch treatment process that generated chromium sludge that would require disposal at a licensed disposal facility. This method of treatment causes site disturbance, can be costly, may require a long period of time to complete, and may not meet the cleanup objectives.

In response, several companies began to develop new methods of addressing the chromium contamination. These innovative methods have been developed to minimize site disturbance, decrease costs and/or the time required to complete cleanup, while also meeting the site cleanup objectives. Some of the innovative methods for the cleanup of hexavalent chromium in soil and groundwater include electrokinetic restoration, constructed wetlands, stabilization/solidification, and reductant injection.

Electrokinetic Restoration

Electrokinetic remediation in soil uses electric currents to extract radionuclides, certain organic chemicals, and heavy metals (including hexavalent chromium), in soil. For electrokinetic remediation, a series of anodes and cathodes, surrounded by process fluid, are placed in the ground, and a current is established across the electrodes. The current produces an acid in the anode compartment that travels across the soil and desorbs the contaminants from the surface of the soil particles. The current also initiates the electromigration and electroosmosis of the contaminants. Heavy metals, including chromium, are removed from the cathodic process fluid, or are deposited at the cathode.

Constructed Wetlands

Constructed wetland treatment technology was initially developed to address acid mine drainage. However, these geochemical and biological process at work in the constructed ecosystem can be applied to chromium contaminated groundwater. The system consists of a concrete or lined basin into which soil, organic matter, and plants common to wetlands are placed. Extracted contaminated water is pumped in to the basin and is filtered and treated in the basin through adsorption, reduction, and precipitation reactions. Water exiting the basin is therefore clean and suitable for disposal to surface water or a publicly owned treatment works. Generally metals can be rendered immobile through reduction and sulfide/sulfate precipitation catalyzed by the biological material in the wetland. After the capacity of the wetland to assimilate metals is exhausted, the basin is excavated and the waste material disposed of in a proper fashion.

Stabilization/Solidification

The solidification and stabilization process technology immobilizes organic and inorganic compounds in wet or dry soils using reagents to produce a cement-like mass. The additives generate a complex, crystalline connective network of inorganic polymers in a two-phase reaction. In the first phase, contaminants are complexed in a fast-acting reaction. In the second phase, macromolecules build over a period of time in a slow-acting reaction. This creates an extremely low permeability mass which inhibits the potential for movement of the contaminants from the mass, thus stabilizing the contaminants permanently. Desired criteria for the stabilized soil include lower permeability than the non-stabilized soil and the ability to hold the contaminants in the stabilized soil matrix, thus allowing only very low contaminant concentrations to leach.

Reductant Injection

Under reductant injection, a reductant, mixed with water, is injected into the subsurface through a series on injection wells or an infiltration trench. The hexavalent chromium is then reduced to trivalent chromium. Trivalent chromium is less toxic than hexavalent chromium. Trivalent chromium also readily sorbs to soil particles and is relatively immobile in the subsurface.

Conclusions

Some of the innovative methods for the cleanup of hexavalent chromium in soil and groundwater include electrokinetic restoration, constructed wetlands, stabilization/solidification, and reductant injection. These innovative methods should be evaluated at sites with hexavalent chromium contamination. The use of innovative treatment technologies may minimize site disturbance, decrease cleanup costs, decrease the time required to complete cleanup, and/or more efficiently meet site cleanup objectives.

References

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