REMEDIATION SOLUTION

ATOMISOL®

Metal Encapsulation Technology

PROCESS DESCRIPTION

Atomisol® Metal Encapsulation **is** an alternative treatment technology for stabilizing toxic heavy metals in soils and production waste streams. The Atomisol® proprietary stabilization systems render high levels of lead, chromium, cadmium, arsenic and other heavy metals into non-leachable, safe forms, suitable for onsite deposition or off-site disposal in Subtitle D landfills or construction debris monofills. Atomisol® treatment technologies are effective in stabilizing metals in soils, sludge, ashes and sediments.

Members of certain crystalline mineral types (Atomisol®) exhibit the property of isomorphism, i.e., a condition present when an ion at high dilution is incorporated by mixing crystal formation into a precipitate, even though such formation would not be predicted on the basis of crystallographic and ionic radii.

The Atomisol® product and process initiates the formation of isomorphous minerals that are representative of the reaction-series association existing between a series of stable mineral solids with analogous chemical formulas and crystal forms. When the atoms have similar sizes and similar physical properties (e.g. specific gravity, optical properties, etc.) a stable isomorphous situation exists.

All precipitation/crystallization reactions tend to carry other constituents (ions) from the mother-solution. Actual precipitation/crystallization occurs in a succession of steps as the process seeks equilibrium. The driving force for precipitation/crystallization is coincident crystal nucleation and heat loss. Initial nucleation is characterized by expanded growth-rate, and greater opportunity for substitutions in the crystal's structure. This mechanism leads to the desired formation of co-precipitated isomorphous minerals in a reaction-series. As co-precipitation accelerates, the larger crystals grow at the expense of smaller crystals with the smaller crystals dissolving and re-precipitating within the larger crystals.

The process continues until equilibrium is reached and the mother-solution is depleted by initial nucleation, co-precipitation, and post co-precipitation. Problematic heavy metal ions are effectively rendered stable, insoluble and non-hazardous within distinct new mineral species.

These processes are cost effective, operationally straight forward and reliable.

There are more than 300 Atomisol® isomorphs.

APPLICATIONS

The Atomisol® technology is field proven and commercialized for stabilizing heavy metals including: lead, cadmium, arsenic, zinc, chromium, selenium, antimony, barium, and copper. Lab scale proof of concept work is underway on mercury. Sites of application include firing ranges, metal laden sediments, mining operations, primary steel manufacturing, ash from thermal destruction, foundry waste, battery plants, electro-plating wastes and military installations.

In an isomorphous mineral certain ions or molecules will enter into the crystal-lattice of a mineral solid without causing any marked change in crystal morphology or other physical properties. For simplicity, this is accomplished by the two ions having similar but not equal radii and the same charge, with the smaller ion radii being preferentially concentrated in early formed specimens of a crystallizing mineral series. For example, a Pb ion commonly co-precipitates with a Ca ion where Pb^{+2} substitutes for Ca^{+2} within a defined crystal lattice to form a common mineral solid. The Pb^{+2} substitution for Ca^{+2} usually occurs based on availability of the closest ion to a vacant crystal-lattice site and in the later stages of the crystallization event when available Ca^{+2} has been naturally depleted (or if the available Ca^{+2} can be manipulated out of the system).

ADVANTAGES

Advantages and Effectiveness: Standard stabilization techniques “encapsulate” or bind heavy metals to contaminated media by adding cement with pozzolonic materials. This approach adds to both volume and mass of the treated material, is difficult to apply, costs more, and has uncertain longevity. The Atomisol® approach involves converting the physical state of the leachable metallic and oxide forms to an environmentally stable mineral and other chemical forms without adding to volume or mass, and avoiding or minimizing offsite disposal costs. The technique typically results in a cost-savings of 20 to 50% over conventional techniques and treatment results are permanent.

During a site remediation the key question is whether or not apatite or other mineral formation can be initiated synthetically, under field conditions. Fortunately, Atomisol® crystal synthesis at ambient conditions is simple and very rapid. Three things are required, as follows:

1. The appropriate reagent mixture.
2. Blending - to initiate and accelerate the formation reaction.
3. Nucleation points - to focus initial formation, and then be taken up in the new mineral.

In some instances, each of these requirements are met with a single reagent. In some cases, additional reagents will improve economic and technical performance. Treatment involves distributing the required amount of reagent(s) within the contaminated media. The natural penetration characteristics of liquid/solid reagents reduce the necessity for very aggressive mixing. The reagent immediately initiates chemical reactions, which form microscopic Atomisol® crystals, and the Atomisol® crystals isomorphically substitute heavy metal contaminants within their structure, eliminating or reducing leachability drastically.

ENVIRONMENTAL BENEFITS

- Reduction in metal contaminant leachability for a broad range of heavy metals including their various forms (i.e., pure, inorganic, organo-metallic, etc.);
- Reduction in environmental risks to soil, groundwater, and ecological receptors after treatment;
- Easily applied at most commercial, industrial and/or mining sites;
- Application is both rapid and cost effective; and
- Does not negatively affect soil properties (i.e., structure and stability) after application

COSTS

Typical Atomisol® application costs will vary depending on soil type, heavy metal type and concentration, form of the heavy metal (i.e., pure, inorganic, oxide, organo-metallic, etc.), site conditions, available resources, location, and regulatory clean-up objectives. Certain specialized metal stabilization applications for, specific troublesome heavy metals, are usually priced on a case by case basis.

When compared to hazardous landfill disposal, Atomisol® applications are typically 30 to 50% less in cost. Larger projects may benefit from economies of scale where small volume projects typically do not.

Bench scale testing can determine optimal treatment application measures, and help achieve greater project cost control.

EFFECTIVENESS

- Very effective at stabilizing the metal contaminant and reducing the TCLP leachabilty by as much as 99% or more.
- Metals that the technology can treat include: lead, cadmium, arsenic, zinc, chromium, selenium, antimony, barium, and copper.
- Lab scale proof of concept work is underway on mercury.
- Currently evaluating potential applications for NORMs (Naturally Occurring Radioactive Materials).

LOGO

ATOMISOL®