Soil, Sediment, Bedrock and Sludge

Chemical Extraction

Introduction:

Contaminant impacted soil and extractant are mixed in an extractor, consequently dissolving the contaminants in question. The extracted solution is then put in a separator, where the contaminants and extractant are separated for treatment and potential additional use.

Description:

Chemical extraction does not eradicate contaminants but is process that allows the separation of hazardous contaminants from soils, sludge's, and sediments, and therefore reducing the volume of hazardous waste that requires treated. This technology employs an extracting chemical and is different from soil washing, which utilises water in large volumes. Commercial-scale units are in operation and vary with respect to the chemical employed, type of equipment exploited, and mode of operation.

The physical separation steps are usually undertaken prior to chemical extraction in order to grade the soil into coarse and fine fractions, assuming that the fines contain that majority of the contamination. Physical separation also enhances the kinetics of extraction through separating out the particulate heavy metals, if these are present in the soil.

Acid Extraction

Acid is commonly used as an extractant. Acid extraction uses hydrochloric acid (HCl) to extract heavy metal contaminants from soils. Soils are initially screened to remove coarse solids. Hydrochloric acid is then introduced into the soil via the extraction unit. The residence time in the unit differs depending on the soil type, contaminants, and contaminant concentrations, but typically has a range of approximately 10 to 40 minutes. The soil-extractant mixture is continuously pumped out of the mixing tank, and the soil and extractant are then separated using a technology called hydrocyclones. When extraction process is complete, the solids are transported to a rinsing system. Here, the soils are rinsed with water to remove entrained acid and metals. The heavy metals are concentrated in a form that makes them suitable for recovery. In the final step, the soils are de-watered and mixed with lime and fertiliser to neutralise any residual acid that may remain.

Solvent Extraction

Solvent extraction is used in combination with technologies, such as solidification/stabilisation, incineration, or soil washing, depending upon the site-specific conditions. Solvent extraction can be used as a stand-alone technology. Metals that are organically bound can be extracted alongside target organic contaminants, consequently creating residuals with certain handling requirements. Some traces of solvent may remain in the treated soil matrix, so the toxicity of the solvent is an important factor when choosing what solvent to employ. The time duration of operation and maintenance for this process is medium-term.

Applicability:

Solvent extraction is known to be effective in treating sediments, sludge's, and soils containing primarily organic contaminants including PCBs, VOCs, halogenated solvents, and petroleum contaminants. The process can be applicable for the separation of the organic contaminants in paint wastes, coal tar wastes, drilling muds, wood-treating wastes, separation sludge's, pesticide/insecticide wastes, and petroleum refinery oily wastes.

Acid extraction is suitable for remediating sediments, sludge's, and soils that are heavy metal impacted.

Limitations:

- Soil types and moisture content levels will adversely affect the process performance.
- Greater clay content could reduce the extraction efficiency and require longer contact times.
- Organically bound metals can be extracted along with the target organic pollutant, which restricts handling of the residuals.
- The presence of detergents and emulsifiers can unfavourably influence the extraction performance.
- Traces of solvent have been known to remain in the treated solids; therefore the toxicity of the solvent is an important consideration.
- Solvent extraction is least effective on high molecular weight organic and very hydrophilic substances.
- Following acid extraction, residual acid that may still be present in the treated soil requires neutralising.
- Capital costs can be relatively high with the technology being more economical at larger sites.
- Meeting stringent heavy metals criteria may prove the process to be uneconomical.

Data Needs:

The controlling factor is critical to the design of the unit and to the determination of whether the technology is appropriate for the waste. Soil properties that should be known include particle size; pH; partition coefficient; cation exchange capacity; organic content; TCLP; moisture content; and the presence of metals, volatiles, clays, and complex waste mixtures.

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Cost:

Economy of scale with respect to the quantity of material treated has a large impact upon the costs incurred.