Soil, Sediment, Bedrock and Sludge

Solidification/Stabilisation

Introduction

Contaminants are encapsulated within a stabilised mass (solidification), or chemical reactions are stimulated between the stabilising agent and contaminants to lower their mobility (stabilisation).

Description:

There are numerous innovations in the stabilisation and solidification technology. The majority are alterations of proven processes and are focussed on encapsulation or immobilisation of harmful constituents. Nine different processes are bituminisation, emulsified asphalt, modified sulphur cement, polyethylene extrusion, portland cement, radioactive waste solidification, sludge stabilisation, soluble phosphates, and vitrification/molten glass.

Bituminisation:

In the bituminisation, wastes are surrounded by molten bitumen and encapsulated when the bitumen cools. The process amalgamates heated bitumen and a concentrate of the waste material, typically in slurry form, in a heated extruder containing screws that merge the bitumen and waste. Water is evaporated from the mixture to about 0.5% moisture, with the final product being a homogenous mixture of extruded solids and bitumen.

Emulsified Asphalt:

Asphalt emulsions are fine droplets of asphalt dispersed in water that are stabilised through chemical emulsifying agents. The emulsions are obtainable as either cationic or anionic emulsions. The process involves adding emulsified asphalts that have an appropriate charge to hydrophilic liquid or semi liquid wastes at ambient temperature. After mixing, the emulsion breaks, the water in the waste is released, and the organic phase develops a continuous matrix of hydrophobic asphalt round the waste solids. In a number of cases, additional neutralizing agents, for example lime or gypsum, may be necessary. After sufficient time the resultant solid asphalt has the waste uniformly distributed all the way through it and is impervious to water.

Modified Sulphur Cement:

Modified sulphur cement is an industrially available thermoplastic material. It is easily melted (125° to 150° C (260° to 300° F)) and subsequently mixed with the waste to form a homogenous molten slurry, which is released to a suitable container for cooling, storage, and disposal. A diversity of mixing devices, for example, paddle mixers and pug mills, can be utilised. The fairly low temperatures used regulate emissions of sulphur dioxide and hydrogen sulphide to permissible threshold values.

Polyethylene Extrusion:

The polyethylene extrusion process involves the mixing of polyethylene binders and dry waste materials by means of a heated cylinder containing a mixing/transport screw. The heated, homogenous mixture leaves the cylinder through an output die into a mold, where it cools and solidifies. Polyethylene's properties create a very stable, solidified product.

Portland Cement:

Portland cement process involves silicates from materials such as fly ash, kiln dust, pumice, or blast furnace slag and cement-based materials like Portland cement. The materials chemically react with water to create a solid cementious matrix which enhances the handling and physical characteristics of the waste. They also raise the pH of the water, which could assist the precipitation and immobilisation of some heavy metals. Cement based binding agents are in general suitable for inorganic contaminants. The efficiency of this binding agent with organic contaminants differs.

Radioactive Waste Solidification:

In radioactive waste solidification treatment, solidification additives are exploited to form a uniform and stable matrix to encapsulate radioactive waste materials.

Sludge Stabilization:

Sludge stabilisation is the addition of a reagent, either slags or cementitious materials, to sludge to alter the material so that the hazardous constituents are in their least mobile or toxic form. Sludge's which leach heavy metals or other contaminants are frequently stabilised to impede the hazardous constituents.

Soluble Phosphates:

The soluble phosphates process includes the addition of a variety of forms of phosphate and alkali to control the pH, in addition to forming a complex metal molecule of low-solubility to immobilise the metal over a wide pH range. Different to the majority of other stabilisation processes, soluble phosphate methods do not change the waste into a hardened, monolithic mass.

Vitrification/Molten Glass:

Vitrification, or molten glass, procedures are solidification methods that use heat up to 1,100° C to melt and convert waste into glass or other glass and crystalline products. The high temperatures break down many organic constituents with few by-products. The contaminants such as heavy metals and radionuclides are incorporated into the glass structure, which is a relatively strong, durable material resistant to leaching. The waste materials can also be liquids, wet or dry sludge's, or combustible materials. Borosilicate and soda lime are the main glass formers and provide the basic matrix of the vitrified product.

Applicability:

For *ex situ* S/S treatment of inorganics, including radionuclides is possible. Most S/S technologies have restricted efficiency against organics and pesticides, with the exception of vitrification, which eliminates most organic contaminants.

Limitations:

- Environmental conditions may impact on the long-term immobilisation of contaminants.
- Certain wastes are incompatible with different processes. Treatability studies are generally required.

Data Needs:

Soil properties that ought to be known are particle size, moisture content, metal concentrations, sulphate content, organic content, density, permeability, leachability, and physical/chemical robustness.

Performance Data:

Performance of *ex situ* S/S hinges on the type of S/S process used.

Cost:

Drivers of the costs are mainly down to the type of waste. The moisture content in the sludge drives up costs and the contaminant concentration and type determines the amount of reagents that require adding to the waste in order to attain the required treatment standards.