Soil, Sediment, Bedrock and Sludge

Thermal Desorption

Introduction:

In this technology, wastes are heated to volatilise water and organic contaminants. The concept is based on a carrier gas or vacuum system that enables the transport of volatilised water and organics to the gas treatment system.

Description:

Thermal desorption is a physical separation process and is not designed to destroy organics. Wastes are heated to volatilise water and organic contaminants. A carrier gas or vacuum system transports volatilised water and organics to the gas treatment system. The bed temperatures and residence times designed into these systems will volatilise selected contaminants but will typically not oxidize them. Hence further treatment trains are required.

Universal thermal desorption designs are the rotary dryer and thermal screw. Rotary dryers are horizontal cylinders that can be indirect or direct-fired. The dryer is as a rule inclined and rotated. For thermal screw units, screw conveyors or hollow augers transport the medium through a covered trough. Hot oil or steam flows through the auger to indirectly heat the medium. All systems need treatment of the off-gas in order to eliminate particulates and contaminants. Particulates are removed by standard particulate removal equipment, for example wet scrubbers or filters. Contaminants are removed through condensation followed by carbon adsorption, or they are destroyed in a secondary combustion chamber or a catalytic oxidiser.

Types of thermal desorption presently available:

<u>Direct Fired:</u> Fire is used on the surface of contaminated media. Contaminants are desorbed from the soil by means of thermal oxidation.

<u>Indirect Fired:</u> A direct-fired rotary dryer heats an air stream, which desorbs water and organic contaminants from soil.

<u>Indirect Heated:</u> An externally fired rotary dryer volatilises water and organics from contaminated media into an inert carrier gas stream. The carrier gas is treated to eliminate or recover the contaminants.

Depending upon the operating temperature of the desorber, processes are commonly classified as either high temperature thermal desorption or low temperature thermal desorption.

High Temperature Thermal Desorption (HTTD):

This is a full-scale technology where wastes are heated to 300 to 500 °C. HTTD is often utilised in conjunction with incineration, solidification/stabilisation, or dechlorination, depending on site conditions. The technology has been proven to produce a final contaminant concentration below 5 mg/kg.

Low Temperature Thermal Desorption (LTTD):

Wastes are heated to between 100 and 300 °C and the process has been proven successful for treating hydrocarbon contamination in all types of soil. Destruction efficiencies in the afterburners of these units is more than 95%, while the equipment could probably meet stricter requirements through minor modifications. Decontaminated soil retains its physical properties. Unless being heated to the higher end of the temperature range, organic components in the soil are not damaged, which allows treated soil to retain its ability to support future biological activity.

Applicability:

The contaminant groups for LTTD systems are typically non-halogenated VOCs and fuels. SVOCs can be treated but at a reduced effectiveness. For HTTD SVOCs, PAHs, PCBs, and pesticides may be treated. The occurrence of chlorine may impact the volatilisation of some metals, such as lead. The process is relevant for the separation of organics from refinery wastes, coal tar wastes, hydrocarbon-contaminated soils, mixed (radioactive and hazardous) wastes, pesticides and paint wastes.

Limitations:

- There are specific particle size and materials handling requirements that can impact applicability or cost at specific sites.
- Dewatering may be necessary to achieve acceptable soil moisture content levels.
- Highly abrasive feed potentially can damage the processor unit.
- Heavy metals in the feed may produce a treated solid residue that requires stabilization.
- Clay and silty soils and high humic content soils increase reaction time as a result of binding of contaminants.

Data Needs:

Soil moisture content, boiling points of contaminants to be treated, and treatability tests to establish the effectiveness for removing contaminants at various temperatures and residence times. Sieve analysis is required to ascertain the dust loading in the system to design and size the air pollution control equipment.

Performance Data:

Most of machinery for thermal desorption systems are accessible easily. All *ex situ* soil thermal treatment systems use comparable feed systems containing a screening device to separate and remove materials larger than 5 cm, a belt conveyor to move the screened soil from the screen to the initial treatment chamber, and a weight belt to determine soil mass. Soil conveyors in more substantial systems are more prone to failure than those in smaller systems. Size reduction equipment can be integrated into the feed system, but installation is typically avoided in order to reduce shutdown because of equipment failure. The duration of time needed to cleanup an 18,000 tonne site using HTTD is in the region of 4-5 months.

Soil storage piles and feed equipment are covered to protection from rain and to minimise soil moisture content and potential material handling problems. Soils and sediments with water contents greater than 20 to 25% may need the installation of a dryer in the feed system to enhance the throughput of the desorber and to assist the conveying of the feed to the desorber. Volatilisation of contaminants will take place in the dryer, with the gases being routed to a thermal treatment chamber.

Cost:

The quantity of material that needs treating has a large impact upon costs, as does the moisture content, which can increase fuel costs depending upon the heating requirements.