Thermal Desorption - A **Viable Solution** James R. Roderick, REM, CHMM
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As regulations continue to tighten, the need for expedient and accurate remediation technology is of great importance. When faced with the demand or need to reach compliance on petroleum-contaminated soil, three things seem to be of primary concern, cost, speed and future liability. Thermal Desorption is a cost effective and expeditious alternative that eliminates the risk of future liability. The soils can be treated on site and replaced or utilized on location.

The most common methods of remediation have historically involved contaminant transfer. Excavating soils for deposit in a landfill, vapor extraction, soil farming, etc. All of these methods are of the "transfer" nature. They either relocate or deposit the soils elsewhere or transfer the contaminant to the air or another media. Thermal Desorption is a long proven method of remediation, which incorporates the "transfer" aspect while ending in a combustion or destruction manner.

Thermal desorption is made of (3) three primary steps: Volatilization, Stripping, Combustion / Destruction. In this process, the temperature of the contaminated media is elevated causing the volatiles and semi volatiles to change into a vapor phase. The vapor phase and particulate matter is then stripped with air. The air is then passed through the baghouse to eliminate airborne particulates and sent into the combustion chamber or afterburner for combustion / destruction / incineration. Since the destruction process only involves the contaminant in the vapor phase portion and not the entire soil structure, there is no ash generated (solid waste) by this process and the soils are viable for reuse.

Thermal Desorption Plants are primarily used in the remediation of soils contaminated in the range of Parts Per Billion (Ppb) to 2% by volume or 20,000 Parts Per Million (ppm). These contaminants tend to be volatiles and semi volatiles such as diesel, gasoline, jet fuels, fuel oils, etc. The results are an environmentally acceptable soil that has been decontaminated in most cases to a non-detectable level. The soils can then be used on site or directly backfilled in the cleaned excavation.

The Thermal Desorption Process can be conducted at a relatively high rate of treatment. The majority of the plants operate in ranges from 18 - 35 tons per hour. Larger plants may operate in excess of 100 tons per hour. Based on the average historical pricing, thermal desorption treatment costs range from $29 to $45 per ton for the 18 - 35 ton per hour plants. Some of the variables in the pricing include the volume to be treated, contaminants involved, soil types, moisture content and the cost associated with the type of combustion fuel used.

When determining if Thermal Desorption is the applicable remediation method for a particular location, there are several thoughts that must be kept in mind.

Contaminants

You must analyze and know ALL contaminants present in the soils. It is important to know if other chemicals (known or unknown) are present that may cause unwanted results when introduced to the heat process. In some cases, dioxins, furans, acid gases and other harmful byproducts could be produced if proper analysis of the soils is not conducted.

The concentrations of the hydrocarbon that can be introduced into the air stream should be limited to less than 25 percent of the Lower Explosive Limit (LEL) if the temperature of the exhaust gas is above the auto ignition temperature for that compound. Lower explosive limits are typically in the range of 1 - 2 percent by volume for most of the common hydrocarbons and the auto ignition temperatures typically range form 500 to 1200 degrees F.

Compounds that do not significantly volatize at temperatures under 1000 degrees F. may not be suitable for the thermal process as this is the maximum temperature related to thermal desorption. Most metal contaminants will not be affected by the process and will remain in soils. Caution should be taken when treating soils with a heavy metal contamination.

The concentration of the contaminant must be within a safe operating range. High concentrations may cause premature or violent reactions within the initial treatment system. High concentrations may also overburden the afterburner and result in incomplete stack treatment or excessive emissions from the stack.

Moisture Content

The effectiveness, speed and cost of thermal desorption is greatly related to and affected by the soil moisture content. Moisture may be absorbed by the soil particles or chemically bound. Moisture content may range from 5 to 30 percent in contaminated soils. Typical moisture concentrations range from 10 to 20 percent. While some moisture is obviously necessary and helpful, elevated moisture levels affect the amount of energy required to heat the soils to the treatment temperature and the treatment process rate and consequently elevates the cost of treatment.

Soil Characteristics

The type or characteristics of the soils to be treated will have a direct effect on the production speed and costs associated with the treatment and handling process. Clays or fine-grained soils with a moisture content at or above the Atterberg plastic limit are more difficult to heat and therefore process, due to the low surface area to volume ratio. These types of soils require more pre-treatment in order to reduce the particle size and make it more difficult to remove rocks and other debris prior to treatment. Pretreatment methods may include mechanical shredding, crushing and air drying or mixing with dryer soils or other inert media.

Soils with high volumes of debris can reduce the speed of the treatment program and increase the cost associated with the overall project. In some cases the presence of small pieces of organic matter such as wood chips, grass, pine needles and bark can create serious issues within the treatment process due to the tendency for those objects to become glowing embers within the treatment unit.

Treatment Temperatures

The effectiveness of the thermal desorption process is directly related to the selected systems ability to elevate and maintain the temperature of the soils for the desired time and at a feasible process speed. The treatment temperature required can be estimated from the distillation temperature range or the virgin product. Technical data indicates the temperatures of the soils must be elevated to point that would cause the contaminant to achieve a vapor pressure of 0.5 to 2.0 atmospheres in a closed system. The boiling point of a compound is the temperature at which the vapor pressure achieves a pressure of 1.0 atmosphere.

Configuration of Thermal Process

When selecting or determining a thermal desorption process, there are several issues to consider. The physical size or footprint required to safely operate a given unit, the process rate or speed, the fuel needs and type to be utilized, the temperatures required and the type of thermal desorption process (direct fired, indirect fired, counter flow or parallel flow).

The physical size or footprint is directly related to the process rate or speed (i.e. 20 tons per hour versus 150 tons per hour) and may also be related to the manufacturer's configuration of the unit.

The process rate or speed (tons per hour) should be carefully weighed. While larger systems may reduce the actual length of the project, they may cost more per ton and may also utilize more fuel per ton of treatment. When considering the size of the unit, along with the footprint requirements, the cost or use of fuel per ton treated should be considered. This information can be weighed against the extended time of a smaller unit to help determine cost effectiveness.

The types of thermal desorption process are typically Direct Fired (the soils and vapors are in direct contact with the flame) Indirect Fired (the heat is transferred through an exchanger with no direct flame contact) Counter Flow (the solid material flows in an opposite direction of the air stream) and Parallel Flow (the solid material flows in the same direction as the air stream). Availability and treatment costs associated with the different types of process is normally the deciding factor. Direct Fired Counter Flow thermal desorption units are most commonly used in the remediation of fuels and fuel oils and tend to be the most cost effective in non RCRA hazardous wastes.

Thermal Desorption. While it is not the answer for every remediation need, it is a viable solution in the remediation of petroleum products. It is reliable and can be a cost effective answer to the need for remediation without future liability.

As with any remediation project, when selecting the type of thermal desorption process and the operating company, always check the company's track record, financial stability and experience in the areas of your needs. Thermal Desorption is not a "dirt in dirt out" process. It requires specific skills, trained and experienced personnel, automated protective devices, the right system for the project and a complete knowledge of the contaminated soils to be treated.