Vacuum Thermal Desorption

The process itself is a batch-wise working process. As drying technology for the vacuum thermal desorption a batch-wise working vacuum shovel dryer is used. The feeding system is depending of the physical characteristics of the input material. Belt conveyors, solid pumps, lifting and tipping devices or screw conveyors are possible. After feeding the material into the shovel dryer, a vacuum tight and temperature resistant valve system is closing the inlet and outlet of the shovel dryer.

The first phase of the treatment is the complete evaporation of the water content present in the input material. In the second phase the volatile organic or mercury contaminants are evaporated at increased heating temperatures and reduced process pressure. The exhaust vapours are purified by a vapour filter, specially designed for the high process temperatures and consisting of metal filter cartridges.

After passing through the vapour filter, the vapours are condensed separately in liquid water and contaminant phases. The vacuum required for the process is produced by a system of vacuum pumps, installed right after the condensation. The exhausted is cleaned by a system of filters and finally passing a charcoal filter. The quality of the output material can be adjusted by the batch time, the final product temperature and the final pressure.

Once the pre-set conditions are reached, the dryer is emptied under atmospheric pressure. When treating organic components, the entire process is covered with Nitrogen to avoid any explosive atmosphere. The heat is provided indirectly to the product by a thermal oil system, fired by natural gas, oil or electricity. This is of course depending on economical aspects and on available resources. The oil evaporated and recovered in the process could be also used for heating up the thermal oil.
Facts and Basics

The treatment of hazardous residues from industrial processes and the rehabilitation of contaminated sites and has become a major environmental challenge. Industry and public authorities have become more environmentally conscientious; this worldwide environmental awareness has corresponded to new laws and regulations concerning all aspects of waste storage, waste treatment and waste disposal and finally is resulting in bans on the disposal of hazardous waste in landfills. In order to comply with the new regulations, the need for alternative technical solutions has increased significantly.

Vacuum Thermal Desorption is fundamentally a thermodynamic separation process. The core of the technology consists of a vacuum shovel dryer, where heat is supplied to the contaminated input material. By heating up, the contaminants are vaporized from the solid or sludge-type input matrix into a gas or vapour stream. In a following process step this vapour stream is treated to meet all regulatory requirements mandatory to be exhausted in the environment. The vapour treatment technology collects and condenses the volatile matter out of the gas stream for further utilization.

The contaminated material typically is heated up to 350 °C product temperature or correspondent 400°C heating temperature. The heating temperature is depending on the quantity and quality of the contaminants to be removed. During the process the material to be treated essentially retains its chemical properties, no cracking or destruction process occurs as it would be when heated to higher temperatures.

The treated material is discharged from the vacuum dryer, cooled down to enable a final remoistening process to avoid dust emissions while conveying, transportation or disposal of this solid output material. Depending on the quality of the input material, the treated output meets all criteria for a class II (non-hazardous) landfill. In some applications, e.g. Natural Gas drilling with low radioactivity (NORM) and high content of heavy metals, the dry output could be Stabilized / Solidified before the final disposal. The entire evaporating process is conducted under vacuum of around 50 mbar absolute pressure. This vacuum is produced by a system of vacuum pumps. The reduced process pressure leads to some significant technical and economical benefits:

- Reduction of the boiling point temperatures of the substances to be removed
- Achievement of higher quality grades of the treated substances
- Reduction of the process time
- Improvement of the energetic and economic efficiency
- Elimination of atmospheric oxygen during the process

Process Diagram
Input Materials

In general, thermal desorption is capable of treating various materials contaminated with a wide range of organic contaminants. But thermal desorption technologies have not only been modified to treat high-boiling-point organic or chlorinated contaminants, but are also capable of treating a variety of mercury contaminated waste streams. The physical properties of the input material could range between:

- Soils, Solids, Earth, Building Rubble, Debris, Dust
- Sediments
- Sludge
- Filter Cake

But what are the typical waste streams to be treated within our Vacuum Thermal Desorption plant? Here are some typical examples:

- By-products from industrial processes, e.g. from chloralkali-electrolyses
- Various mercury waste streams
- Residues from Natural Gas drilling (NORM-sludge)
- Crude oil tanker bottom’s and other marine waste
- Oily sludge
- Refinery tank bottom’s
- Refinery waste
- Coal tar waste streams
- Road surface break-up containing tar
- Mixed hazardous waste
- Oil & Gas drilling waste and drill cuttings
- Grinding swarf
- Contaminated filter cakes
- Pesticides

Very good process performances have been proved for the following types of contaminations:

- Volatile Organic Compounds (VOC)
- Mineral Oil Hydrocarbons (MOHC) up to C40
- Polyaromatic hydrocarbon’s (PAH’s)
- Polychlorinated biphenyl’s (PCB’s)
- Mercury (Hg)
- Trichloroethane (TCE), Perchloroethene (PCE)
- Other chlorinated and polyaromatic organic compounds (BTEX, CHC, etc.)

The concentration of the pollutant, also the amount of water inside the input material is almost irrelevant. Although it must of course be taken into consideration in regard of the dimensioning of the equipment and the accordant process parameters.
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Mercury concentrations after treatment < 10 ppm

- TPH concentration after treatment < 1%

- Stabilization / Solidification process e.g. for heavy metals could be included

- Output normally applicable for class II landfill

The quality of the output material is depending of course on the waste input material, the process design, the requirements of the client, economical aspects and restrictions of environmental laws and regulations. Typically the following values could be achieved:

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- TPH concentration after treatment < 1%
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- Output normally applicable for class II landfill
Process Description

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Vacuum Dryer

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Flowsheet
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